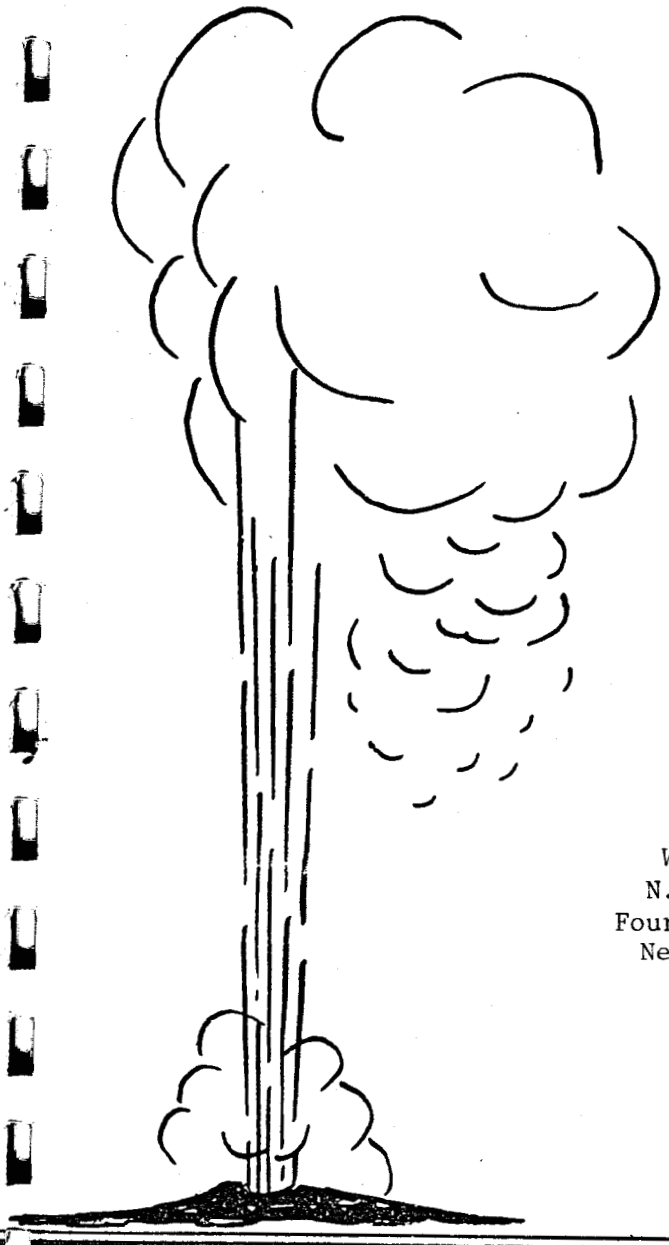
ALO-3992

UTAH SOUTHWEST REGIONAL GEOTHERMAL DEVELOPMENT OPERATIONS RESEARCH PROJECT

Appendix 10 of

REGIONAL OPERATIONS RESEARCH PROGRAM
FOR DEVELOPMENT OF GEOTHERMAL ENERGY
IN THE SOUTHWEST UNITED STATES



Final Technical Report
June 1977 to August 1978

Utah State Enginner Office
Stanley Green
Lyle W. Wagstaff

January 1979

Work Performed under DOE Contract No. EG-77-S043992
N.M.Energy and Minerals Department Project No. 76-262
Four Corners Regional Commission Contract No. 672-066-075
New Mexico State University Sub-Contract No. 3104-X8

New Mexico Energy Institute at
New Mexico State University
Las Cruces, New Mexico 88003

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INTRODUCTION

The Southwest Regional Geothermal Operations/Research project was initiated to investigate geothermal development in the five states within the region: Arizona, Colorado, Nevada, New Mexico, and Utah. Although the region changed during the first year to include Idaho, Montana, North Dakota, South Dakota, and Wyoming, the project objectives and procedures remained unchanged.

The project was funded by the DOE/DGE and the Four Corners Regional Commission with participation by the New Mexico Energy Resources Board. The study was coordinated by the New Mexico Energy Institute at New Mexico State University, acting through a "Core Team." A "state" team, assigned by the states, conducted the project within each state.

This report details most of the findings of the first year's efforts by the Utah Operations/Research team. It is a conscientious effort to report the findings and activities of the Utah team, either explicitly or by reference. The results are neither comprehensive nor final, and should be regarded as preliminary efforts to much of what the Operations/Research project was envisioned to accomplish. In some cases the report is probably too detailed, in other cases too vague; hopefully, however, the material in the report, combined with the Appendices, will be able to serve as source material for others interested in geothermal development in Utah.

OPERATIONS/RESEARCH

Although geothermal energy has been used for some time in certain areas of the world, it is a relatively new industry in the United States. Electricity has been produced from geothermal resources at the Geysers area in California since 1960, but to date there are no other commercial geothermal power plants in the United States. Nevertheless, the country does have significant potential resources which could be used to produce electricity or to provide heat directly.

The awareness that the United States is not energy-independent has spurred interest in energy sources in addition to fossil fuels. Because of the increasing costs of energy and a national desire to be as energy-self-sufficient as possible, interest in geothermal energy has grown tremendously in the last four to eight years. The industry is still fledgling; and, as is the case for any newly developing industry, it has encountered substantial barriers. Thus the desire to utilize this important and valuable energy source has often been frustrated by cross-purposes and counterproductive regulatory measures.

The goals of the Department of Energy, Division of Geothermal Energy, are to foster the development of geothermal energy. The goals are expressed not in terms of accomplishments by the DGE but in terms of progress in geothermal development by the geothermal industry. This mission-oriented approach requires realistic assessments of both potential and impedance in order to set meaningful goals and define

specifically the steps required to reach them.

The purpose of the operations/research studies is to provide DGE with the information needed to set and reach the national goals of utilization of geothermal energy. The primary means of conveying this information will be the compilation of hydrothermal development profiles or scenarios. The purpose of the operations/research studies is to develop these profiles.

The essential elements of the development profiles are an assessment (or assumption if no estimate is available) of the resource characteristics, an analysis of the private and public actions needed to bring development to fruition, and an estimate of the time frame within which development is likely to occur. The assessment of the reservoir would be based on the best current information. The analysis of public and private actions would be quite detailed and would include input from the industry, state, federal, and local agencies, and other groups and individuals most directly involved. The institutional analysis would also include an evaluation of existing and potential impediments and recommendations for overcoming them.

The Southwest Regional Geothermal Operations/Research Study originally encompassed the southwest region (the states of Arizona, Colorado, Nevada, New Mexico, and Utah). The project was funded by the DOE, the Four Corners Regional Commission, and the New Mexico Energy Resources Board. The main contract was with the New Mexico Energy Institute at

New Mexico State University at Las Cruces.

The project was organized with a "state team" in each state to conduct the research for that state. The efforts of the state teams were coordinated by a "core team" at the New Mexico Energy Institute. The core team also set up a data bank on computer, conducted economic and sensitivity analyses, and aggregated and compiled the output from the state teams, both in terms of energy on-line and institutional factors.

In Utah, the study was assigned by the Governor to the Division of Water Rights, which is the primary regulatory agency for geothermal exploration and development in Utah. The Utah team consists of a team leader, Stanley Green, who is also Directing Appropriations Engineer for the Divison; a hydrologic engineer, Ward Wagstaff, whose primary responsibility is the operations/research project; and a secretary, Jayel White.

LEASING

State of Utah

State lands in Utah were officially opened to leasing for geothermal exploration and development in June, 1973, and geothermal leases were issued in August of that year. A few leases for geothermal resources on state lands had been issued in 1968 and 1971 on a special use basis.

In most townships, sections 2, 16, 32, and 36 are owned by the state. The state has also acquired some lands from other sources, e.g., transfer from the federal government. On some of these lands the federal government retained control of the mineral rights. Other state lands have been sold to individuals with the mineral rights reserved to the state; so in some cases the state owns surface rights but not mineral rights, and, in other cases, the state controls the mineral rights but not the surface rights.

Leases on state lands are handled by the Division of State Lands. Geothermal leases are issued for an initial period of ten years and can be extended. Rental for geothermal leases is $1.00 per acre, and the royalty is 10% (Utah: Geothermal Steam Lease and Agreement).

The geothermal lease entitles the lessee to access, exclusive drilling and exploratory rights, etc. The Rules and Regulations require that plans of operation and other data be submitted to the Division of State Lands.

If a discovery is made, it will be necessary to obtain a special use permit for building or other surface-disturbing activities from the Division.

The rules and regulations governing the issuance of leases of state lands in Utah state that lease applications will be considered in the order in which they are filed. Lands which become available for leasing, whether because they are newly acquired or because an existing lease is terminated for any reason, are issued by simultaneous filing procedures. This means basically that they are issued by sealed competitive bidding. The bid constitutes the first year's rental (minimum $1.00 per acre or part thereof), and the lease is issued to the highest "responsible, qualified bidder." In case of identical bids a public drawing is held (State of Utah Rules and Regulations Governing the Issuance of Mineral Leases).

The time required for the granting of a regular lease is from a few days to a week, and seldom more than about ten days. The Director of the Division of State Lands meets each Monday to consider leases. For leases granted under simultaneous filing procedures, the time required is up to 15 days. The bids are opened on the last Monday of each month and may be submitted until one working day prior.

To date, no applications for special use permits for the construction of power plants have been submitted, but it is estimated that the process would take about two months (Prince, 1978).

Federal Government

As of 1971, about 67.1% of the state of Utah was administered by the federal government, including Indian Lands. Geothermal leases for federal lands were first issued in 1974. Since that time considerable leasing has taken place, particularly in the west central and southwest parts of the state where federal land is found in higher proportions.

The federal leasing procedure is complex and restrictive. Obtaining a lease on federal lands takes at least six months; and many lease applications, particularly in some other states, have been pending since 1974 without action. After the leases have been approved, each step in the development must be approved, a process which may take from three to five months or longer for each step if environmental problems are encountered. The developer may also have to cope with severe restrictions or changing requirements.

An application to lease federal land is filed with the Bureau of Land Management (BLM). The surface management agency (BLM, U.S. Forest Service, Bureau of Reclamation) then conducts an Environmental Assessment (EAR) or, when the land is National Forest land, an Environmental Investigation (EIS). The various agencies involved provide input to the stipulations of the lease, which is subsequently issued by the BLM if the EAR/EIS is satisfactory.

The annual rental on federal geothermal leases is a minimum of $1.00 per acre or fraction thereof and may be higher. Beginning with the sixth year and continuing until the

production of geothermal resources, the rental is raised by $1.00 per acre each year (Federal Regulations on the Leasing of Geothermal Resources, § 3025.3-2 and 3205.3-3).

Once the lease has been issued its terms are administered by the USGS. Certain non-surface-disturbing activities such as geophysical surveys and shallow temperature gradient surveys may be permitted under a casual use or special use permit which are issued within 30 days. For major exploratory activities, such as deep exploratory wells, a plan of operation is filed with the USGS. A site-specific environmental analysis is conducted by the USGS, and if it proves satisfactory a permit is issued with stipulations. Again, the surface management agency may have input to the stipulations and joint approval rights with the USGS.

In the course of a geothermal development six plans of operation must be submitted to the USGS and approved by them. The first of these is the plan of exploration, which includes the deep exploratory wells and associated activity, and which may take up to a year for approval. As development proceeds, plans of operation must be submitted for the acquiring of one year's environmental baseline data, development of the geothermal field, injection, production, and utilization, each of which involves a site-specific environmental assessment and the granting of a permit. These later permits can probably be issued in three to five months (Bull, 1978).

A potential resource area can be declared a Known Geothermal Resource Area (KGRA) if (1) the USGS determines that

the geology of the area indicates the presence of a geothermal resource, (2) if a discovery is made nearby, or (3) if two or more parties file for geothermal leases on the same area (Federal Regulations on the Leasing of Geothermal Resources, § 3200.0-5). When an area is declared a KGRA the leases are issued by competitive bid and the annual rent is elevated.

Federal regulations state that the acreage limitation for a single lease is 2560 acres in a "reasonably compact area," with provisions for exceptions. The maximum acreage which any entity can lease within any single state, whether directly, by assignment, or part interest, is 20,480 acres. Leased lands which are included in a unit or cooperative plan are not included in the total acreage computations (Federal Regulations on the Leasing of Geothermal Resources, § 3201.2 and 3203.2).

Leasing in Utah

Extensive leasing has occurred in Utah, both on state and federal lands. Much private land has also been leased, but private lease records are not readily available, and analysis of private leases is not included in this report.

As part of the initial phase of this study, the state and federal lease records were compiled and integrated. The purpose of this exercise was to provide background information on the possible location of geothermal resources. In an attempt to determine specific sites as a basis for a "site-specific" approach to scenarios, sites were tentatively defined according to leased areas. Because this definition

was unrealistic in terms of the location of the resources and because it tremendously increased the amount of analysis necessary to produce meaningful scenarios, the leasing area definition of a site was dropped in favor of the "prospect" concept.

The leasing situation is not static. After the initial attempt to compile state and federal leases had been made, it was found that the information available to the study team had been incomplete. A second effort was made to compile the leases, and this information, current as of February 1, is regarded as more complete and reliable than the original information; still, there are several discrepancies, and the data are already outdated.

Nevertheless, the lease data proved valuable by providing a number of insights into the way geothermal development has been approached in the state. In many cases, lease patterns show up clearly as a speculative venture by the lessee. More serious developers tended to lease larger, more contiguous blocks of land. The speculative lessees tended to avoid KGRA lands, whereas major developers did not. The smaller lessees usually assigned their lease to major developers, and the major developers--exploration companies and oil companies--have done nearly all the drilling in the state, both temperature gradient holes and deep exploratory wells. Of course, one can really only speculate as to which lessees are speculators; but the patterns are interesting.

Another interesting aspect of the leasing patterns is the proportion of state land leased relative to the proportion

of federal land leased. Using 1971 figures, federally administered lands comprised 67.1% of the state, state-owned lands accounted for 6.8% of the state, and privately owned land accounted for 21.5%. If only state and federal lands are considered, 90.8% is administered by the federal government, and 9.2% by the state. The February figures for leasing, again excluding private lands, showed that 67.0% of the total state and federal lands leased in the state were federal lands, and 33.0% were state lands. This is a crude comparison, but it demonstrates that a higher proportion of state lands have been leased compared with federal lands. It also indicates that it would probably be a false assumption to estimate the acreage of private leases based on the proportion of private land to the total land area in the state; hence, no figures for private leases have been projected.

Due to the constant changes in leases, the limited function of lease data in the study, and the amounts of time involved in analyzing lease data, the lease information has not been updated since February. The federal lease information compiled at that time appears to be significantly different from lease information received from the BLM in June and dated in March. Both sets of information are presented, as Table 1 and 2.

TABLE 1

FEDERAL AND STATE GEOTHERMAL LEASES
UTAH
(As of February 1, 1978)

Operator	Federal Leases KGRA No.	Federal Leases KGRA Acreage	Federal Leases Non-KGRA No.	Federal Leases Non-KGRA Acreage	State Leases No.	State Leases Acreage
1. Agri-Empire					4	3457.57
2. Alta Energy Corporation			1	1981.28	1	1367.52
3. AMAX Exploration			3	3808.78	12	8535.16
4. American Geological Enterprises			5	6339.69		
5. American Geothermal Energy, Inc.	3	7579.19				
6. American Oil Shale Corporation					7	5566.46
7. Aminoil USA, Inc.	2	4067.46				
8. Amoco			1	1923.19		
9. Anderson, Stephen					3	3237.02
10. Armstrong Dale E.					1	760.00
11. Atlantic Richfield			7	11,735.63		
12. Barnes, Roy E.					4	2450.00
13. Barr Ronald C.					6	3678.57
14. Blankenship, Jack E.					1	1158.89
15. Bountiful City Corporation			1	40.00		
16. Bradshaw, Melvin					2	90.33
17. Brown, J.G.					3	4139.18
18. Chevron Oil Corporation	1	2532.88	11	19,698.65	16	13,363.31
19. Christensen, L. Deral, and Peterson, Hearld					1	80.00
20. Ciancanelli & Gillett			8	16,777.55		
21. Clinton Oil Corporation					1	638.32
22. Colman, William J.			3	5823.83		
23. Covello, J.W.					5	3532.23
24. Davon, Inc.			5	7773.16		

FEDERAL AND STATE GEOTHERMAL LEASES
UTAH
(As of February 1, 1978)

Operator	Federal Leases KGRA No.	KGRA Acreage	Non-KGRA No.	Non-KGRA Acreage	State Leases No.	State Leases Acreage
25. Earth Power Corporation			10	19,302.91	1	766.44
26. Energy Partners, 1974			8	17,236.68		
27. Fisher, Milton			3	5721.26		
28. Flying Diamond Oil Company			1	1920.00		
29. Folmar, Cecil J.			5	7853.53	2	1920.00
30. Geothermal Exploration Co.			6	8936.62		
31. Geothermal Kinetics			2	3083.36	9	13,633.12
32. Geothermal Power Company			1	640.00		
33. Geothermal Resources International	6	14,338.25	2	4645.23		
34. Getty Oil Company	1	1920.00				
35. Golding, Charles L.	2	3360.00	9	8483.91	9	8418.55
36. Gulf Oil Corporation			2	3852.84	16	19,581.54
37. Harper, Robert C.					4	4452.36
38. Hunt	2	2340.00	14	19,189.40	1	56.77
39. Intercontinental Energy					3	1748.72
40. Justice, Malcolm F. Jr.			1	2182.24	1	360.29
41. Ladd Petroleum Company			1	2560.00		
42. Magma Power Company					1	2000.00
43. McCormick, Sonja V.					1	2710.88
44. O'Brien Resources Corp.			6	11,661.91	2	2428.96
45. O'Brien/Thermal Power					3	2547.46
46. O'Brien/Altex					2	240.00
47. Pacific Energy Corporation			8	13,320.12		
48. Papulak, Kay			1	640.33		

FEDERAL AND STATE GEOTHERMAL LEASES
UTAH
(As of February 1, 1978)

Operator	Federal Leases KGRA No.	Federal Leases KGRA Acreage	Federal Leases Non-KGRA No.	Federal Leases Non-KGRA Acreage	State Leases No.	State Leases Acreage
49. Papulak, Milan S.			3	7360.86		
50. Phillips Petroleum Company	10	17,688.965	12	16,589.87	65	69,869.63
51. Pucket, R. E.					1	1000.00
52. Republic Geothermal	1	1200.58	15	29,768.77		
53. Resource Leasing Corporation					2	1293.44
54. Seltzer, Gary W.	1	1200.00	3	5759.37		
55. Steam Corporation of America			2	3416.50	4	1886.14
56. Stevenson			3	4547.85	3	1763.53
57. Supron	3	5486.79	5	11,042.86	5	2623.32
58. Thermal Power Company					11	11,613.89
59. Thermal Power/O'Brien/AMAX/ (VTN)					1	640.00
60. Thermal Resources, Inc.			6	12,323.11		
61. Thermex	2	3840.00	2	3737.65		
62. Union Oil of California	14	18,620.98	6	5037.90		
63. United States Geothermal Corp.			11	20,382.64		
64. Utah International			1	2077.00		
65. U. V. Industries					7	6259.02
66. Weiner, Ted			1	1381.00		
67. Western Geothermal, Inc.	2	1721.95				
68. Windsor, Trevar L.			4	8348.72		
TOTAL	50	86,447.045	199	340,011.35	221	210,559.66
		13.6%		53.4%		33.0%

Total State and Federal Leases
637,028.04 acres

TABLE 2

Federal Leasing in Utah

Status of Lease Sales on KGRA's

	BLM	USFS
Total Federal Acres	83,215	15,572
Theoretically Available for Leasing	83,215	15,572
Acres Offered	78,966	10,852
Acres Bid On	77,277	10,852
Acres Accepted	77,277	10,852
Federal Acres Remaining for Lease	7,138	4,719

From Interagency Geothermal Streamlining Task Force, 1978.

DRILLING

The Utah Division of Water Rights is the regulatory agency for geothermal wells and development. As such, it has access to records including the locations of all legal temperature gradient wells and exploratory wells. Also on record at the Division are the well logs, temperature data, and other information. This information is proprietary and cannot be released without permission from the developer. As a result, the kinds of information which would be very useful in assessing potential resource areas cannot really be used.

A major problem in development forecasts for a truly specific site is the location, boundaries, and reservoir characteristics of the resource at that site. The initial approach of the Operations/Research study was to use lease information to define boundaries and drilling data to estimate the reservoir characteristics. However, lease boundaries are artificial and most of the drilling information is confidential. Hence, the site-specific approach evolved into a "prospect" approach, which is much more realistic and easier to work with but which is substantially less specific.

Temperature Gradient Drilling

Temperature gradient wells are narrow diameter holes drilled to determine temperature-depth relationships and to calculate the heat flow. Temperature gradient wells may be several thousand feet deep but are usually drilled only a few hundred feet. When completed, they consist of a narrow

diameter pipe or tube extending the length of the hole, sealed at the bottom and filled with water. The hole is filled in around the tube and the water in the tube is allowed to equilibrate to the ground temperature of the various geologic strata. A temperature probe is used to determine the temperature profiles through the length of the tube. The cost of a temperature gradient hole varies with depth, and may range from $40,000 to $60,000 for a hole a few thousand feet deep (Berge, 1978; Ward, 1978).

The rules and regulations governing exploratory drilling for geothermal resources state that permission must be obtained from the State Engineer in order to drill temperature gradient wells. Applications are made by letter, including the plan of operations; and permits are issued by letter. The permits are valid for six months and may be extended by request to the Division of Water Rights. The Division is to be notified when drilling will begin. Temperature data and well logs are to be submitted to the Division. When the survey is complete, the casings must be capped, or they may be pulled and the hole cemented (Utah, Rules & Regulations).

A total of 225 temperature gradient well applications have been filed with the Division of Water Rights. Often a whole series of wells will be included on one application. The data from the well need not be sent in until the survey on the well has been completed, and no notification is required if a well is not drilled. Hence, Division records do not show exactly how many temperature gradient wells have

actually been drilled. The situation is complicated by the fact that some temperature gradient wells have been drilled illegally, i.e., without the necessary permit from the state.

On federal lands, temperature gradient holes up to 2000 feet may be drilled under a special use license. If the holes are to go below 500 feet, a plan of exploration must be filed with the USGS. If the holes are to be drilled on land not leased by the developer, and the holes are less than 500 feet, a special use license may be obtained from the BLM or USFS.

Geothermal Exploratory Wells

Deep wells drilled to test for geothermal resources are larger diameter (up to 26 inches at the surface) and deeper (up to 10,000 feet) than other types of geothermal exploratory wells. The rigs are, of course, much larger; and the extra workers, equipment, and time involved make these wells much more expensive, from $600,000 to nearly $2,000,000 per well.

Deep exploratory wells must be approved by the State Engineer. Application is made by letter to the state, and a plan of operations must be submitted. The Rules and Regulations spell out in some detail the requirements for the plan of operations, fees, bonds, casing requirements, well spacing, directional drilling, blowout prevention equipment, logging, records, etc. The permit to drill is issued by letter within a few weeks (or faster, if necessary).

The State has regulations regarding blowout prevention

equipment (BOP or BOPE) tests. A test of the BOPE is required, and the Division should be notified so that Division personnel may observe the test.

Federal regulations specify that plans of operations be filed for deep drilling. Site-specific environmental assessments (EA or EAR) must be conducted, and the entire approval process may take up to a year. Because of the long approval time, most developers file a plan of operation which includes as many wells as is foreseen. Federal regulations for drilling are quite stringent and are explained in detail in the Federal Rules and Regulations and in the Geothermal Resources Operations Orders (GRO Orders).

To date, 17 deep geothermal exploration wells have been drilled in Utah and two are currently being drilled. The wells are summarized in Table 3. A short, general history of drilling in Utah follows.

Roosevelt Hot Springs

The first well drilled at Roosevelt Hot Springs was drilled by a railroad crew which was seeking fresh water. In 1968 an experimental geothermal well was drilled by private individuals which hit steam at about 280 feet.

In 1975 Phillips Petroleum Company drilled a deep test well (Well #9-1) on federal leases on the west side of the dome fault. The well was dry, but the temperatures were promising. Phillips then drilled a discovery well (Well #3-1) on the east side of the dome fault. However, after a few weeks the casing collapsed on Well #3-1 and Phillips drilled

TABLE 3

DEEP GEOTHERMAL EXPLORATION WELLS

Roosevelt Area

Phillips Petroleum Company

3-1 (1975)
North 2740 feet and East 2850 feet from the SW Corner of Section 3, T27S, R9W, SLB&M.

9-1 (1975)
South 1000 feet and West 2560 feet from the NE Corner of Section 9, T27S, R9W, SLB&M.

13-10 (1975)
South 1882 feet and East 200 feet from the NW Corner of Section 10, T27S, R9W, SLB&M.

25-15
South 2719 feet and East 1094 feet from the NW Corner of Section 15, T27S, R9W, SLB&M.

82-33 (1976)
South 1284 feet and West 77 feet from the NE Corner of Section 33, T26S, R9W, SLB&M.

54-3
SW½SW¼NE¼, Section 3, T27S, R9W, SLB&M.

12-35
South 750 feet and East 100 feet from the NW Corner of Section 35, T26S, R9W, SLB&M.

Thermal Power Company

72-16 (1976)
South 990 feet and West 990 feet from the NE Corner of Section 16, T27S, R9W, SLB&M.

14-2 (1976)
South 2310 feet and East 350 feet from the NW Corner of Section 2, T27S, R9W, SLB&M.

24-36 (1977)
South 2310 feet and West 4290 feet from the NE Corner of Section 36, T26S, R9W, SLB&M.

Getty Oil Company

52-21
South 990 feet and West 2310 feet from the NE Corner of Section 21, T27S, R9W, SLB&M.

Cove Fort/Sulphurdale Area

Union Oil Company

Forminco No. 1
South 89°55'56" West 310.96 feet and South 821. 59 feet from the NE Corner of Section 29, T25S, R6W, SLB&M.

42-7
SE¼NE¼NW¼, Section 7, T26S, R6W, SLB&M.

31-33
NW¼NE¼NW¼, Section 33, T25S, R6W, SLB&M.

North Cove Fort Area

Caroline Hunt Trust Estate

CHTE 15-30
NW¼NW¼SW¼, Section 30, T24S, R6W, SLB&M.

Thermo Area

Republic Geothermal, Inc.

57-29 (1977)
East 3280 feet and South 4030 feet from the NW Corner of Section 29, T30S, R12W, SLB&M.

Beryl Area

McCulloch Oil Corporation, Geothermal Kinetics, Inc., and Utah Power and Light

MCO-GKI-UPL-DeArman #1 (1976)
North 431.78 feet and East 1645.83 feet from the SW Corner of Section 18, T34S, R16W, SLB&M.

State #1 (1976)
SE¼NE¼NW¼ of Section 22, T34S, R16W, SLB&M.

Jones #1-8 (1977)
Center of NE¼ of Section 8, T34S, R13W, SLB&M.

North Wasatch Front/Brigham City Area

Utah Power and Light

Utah Steam Venture #1-Davis (1974)
South 2510 feet and West 4950 feet from the NE Corner of Section 16, T10N, R2W, SLB&M.

Well #54-3 nearby, also a producing well. Later in 1975, Wells #12-35 and #13-10 were drilled, both producing wells; and Well #82-33, a dry hole, was drilled late in the year.

In the early fall of 1976, Phillips drilled Well #25-15, a producing well. Shortly thereafter, the Thermal Power Company drilled Well Utah State #14-2 on state land, also a producing well. In October of 1976, Thermal Power drilled a second well, Utah State #72-16, also on state land. This well was about 1245 feet deep and appears to be a very high producing well.

In late 1977, Thermal Power drilled a test well (Utah State #24-36), again on state land, in the northeast part of the prospect. The well was not producible. In early 1978, Getty Oil Company drilled a deep test well in the south part of the prospect (USL-52-21). The well test results have not yet been made public, but apparently the well could not be classified as a discovery well.

The wells drilled so far at Roosevelt, when combined with heat flow and other information, seem to indicate that the dome fault is the controlling feature at the prospect. The west edge appears to be the dome fault, and Wells #82-33 and #24-36 are apparently outside the reservoir boundaries. The Getty well at the south end of the prospect may or may not indicate a southern limit; when compared with heat flow data compiled and analyzed by Dr. David Chapman at the University of Utah, it appears that the heat flow does in fact decrease through the south part of the prospect.

As far as known, no extraordinary geological or technical problems have been encountered in the Roosevelt Prospect. The water is hot but comparatively low in TDS. The wells have ranged up to 6,000 to 7,000 feet, but drilling has not been particularly difficult.

The three Thermal Power wells and the Getty well were drilled with assistance from the DOE industry coupled case study program. This program essentially provides money for the drilling; in return, the data and information are made available to the DOE which releases it to the public.

Cove Fort/Sulphurdale

The Cove Fort/Sulphurdale Prospect has been considered a prime prospect for geothermal resources. An area of thermal alteration at Sulphurdale has been mined for sulphur for many years. The federal leases at Sulphurdale were issued by competitive bidding.

In the summer of 1976, Union Oil Company drilled an 1100 foot deep well on private leases (Forminco Well #1). Drilling was very difficult due to adverse geologic conditions, and the well eventually caved in.

The Cove Fort/Sulphurdale Prospect was unitized in January, 1977, with Union Oil Company as the operator and Phillips Petroleum Company and AMAX Exploration, Inc., as the other unit members. W. H. Hunt joined the unit in January, 1978.

As unit operator, Union drilled a second deep exploratory well in late 1977 (Cove Fort/Sulphurdale Unit Well #42-7). The well was drilled on federal leases several miles

north of the original well; but again, drilling was very difficult. The well was drilled with federal assistance under the Industry Coupled Case Study Program (the Forminco well data were also bought retroactively by the DOE), and the data from the well will be made public. However, it appears at this time that the well was not a discovery well.

Union is currently drilling another well (U.S.A. Well No. 31-33) in the Cove Fort/Sulphurdale area, somewhat between the other two wells. It is also being drilled with federal assistance through the DOE case study program.

The drilling problems at Cove Fort are apparently due to an extensive porous rock system which causes loss of circulation. More information on this condition will be available when the case study data are released. In any case, the geologic conditions make drilling very expensive. It is to be hoped that the problems may be overcome, and that as more drilling is done and more is learned about the geologic conditions, the developers and drillers will be able to cope more effectively with the particular difficulties encountered in this area.

Thermo Hot Springs

The Thermo Hot Springs area is a prime prospect for geothermal development, although it is estimated to have a lower electrical potential than the other major prospects in Utah (Roosevelt and Cove Fort). Notwithstanding, a considerable amount of geological and geophysical exploration has been conducted in this area by several developers, including

extensive temperature gradient surveys.

In late 1977, Republic Geothermal, Inc., drilled a deep exploratory well on federal leases a few miles from the hot springs (Well Escalante #57-29). Republic reported no significant drilling problems. Smith, et al.(1978), report that the well went to 7288 feet, that temperatures of 350°-400° F. (about 175°-205° C.) were encountered, that the natural flow rates are low, and that the fluid has a low salinity. Republic and other developers continue to investigate the area and more drilling will probably occur within the next few years.

Beryl/Escalante Desert

The area near Beryl and in the surrounding Escalante Desert holds some promise for geothermal resources. In February, 1976, McCulloch Oil in a joint venture with Utah Power and Light and Geothermal Kinetics drilled a deep exploratory well (MCO-GKI-UPL State #1). The well did not prove commercial, and a second well was drilled in April, 1976, several miles away (MCO-GKI-UPL - DeArman #1). In January, 1977, a third well was drilled (Jones #1-8) further east in the Escalante Desert.

None of the wells were suitable for electrical production, although good flows and boiling temperatures were encountered. The complete data from the McCulloch wells are not public. However, there is potential for direct utilization at the existing wells and further exploration of the Escalante Desert, possibly including exploratory wells, will probably occur in the next few years.

North Cove Fort

The Cove Fort geothermal prospect can be considered to cover a wide area. USGS Circular 726 assumed a default reservoir area to be 15 km^2 (USGS Circular 726). Other potential prospects appear to be generally associated with the Cove Fort anomaly.

The Caroline Hunt Trust Estate (CHTE) has rights to some private leases north of Cove Fort in the White Sage Flat-Dog Valley area. The Hunt Energy Corporation, which is handling exploratory activities for CHTE, is currently drilling a deep well on these lands (Well CHTE #15-30). The well is not completed, and data from the drilling operations have not yet been released. However, it appears that drilling in this area may be difficult, as has been the case at Sulphurdale.

Box Elder County

In 1974, Utah Power and Light and Geothermal Kinetics drilled a deep exploratory well (Utah Steam Venture No. 1) north and west of Brigham City in Box Elder County. The well did not prove to be commercial and was subsequently abandoned.

The geothermal resources in this area and along the Wasatch Front in general are quite plentiful in the low to moderate temperature range. As such, the potential for direct utilization is very good; but the electrical potential in this area appears to be slight.

POTENTIAL GEOTHERMAL RESOURCE AREAS

One major task of the Operations/Research study was to identify the potential geothermal resource areas within the state. This task was assigned specifically to resource assessment study groups in each state; however, in some of the states, including Utah, the resource assessment groups were not formed until the Operations/Research had been underway for some time. As a result the Operations/Research team was compelled to gather the resource data available in order to complete the tasks of cataloging resource areas and uses and projecting possible development forecasts.

One problem encountered in identifying potential resource areas was defining them. Initially the approach was to attempt to define them specifically on a geological-technological basis according to lessee. This approach provided useful background information but was inadequate because the only information actually available was the lease information. To develop scenarios for individual leases or lease goups without regard for other factors would not have been meaningful.

As the study progressed, the concept of a "prospect" evolved and became the basis for the scenarios which were eventually developed. The lease information was very important to this approach because it identified potential developers within a general area, and also was necessary in understanding certain rather specialized situations, e.g., the interactions between developers at Roosevelt Hot Springs.

The advantage of using prospects as the basis for scenarios is that it does not require as much specific information (which is usually unavailable) or as many specific assumptions; as a result it is more manageable and probably more accurate over the long term. The disadvantage is, of course, the lack of specificity in the analysis. Undoubtedly, as more specific information becomes available the basis for the scenarios will shift to more specific sites.

Electrical prospects within the state were determined on the basis of known resources (Roosevelt Hot Springs), industry interest as evidenced by exploratory drilling (Cove Fort/Sulphurdale, Thermo, and the North Cove Fort Area), and as evidenced by exploratory activities and geological indicators (West Cove Fort, Thermo, Black Rock Desert, and others). There is apparently information about seven specific areas of high heat flow in the Iron-Beaver-Millard Counties area (Ward, 1978), but this information is apparently proprietary and at any rate is a well-kept secret.

The prospects for which scenarios were prepared are listed in Table 4.

Direct use prospects are more difficult to define specifically. For the purposes of the study, hot springs or hot springs groups were considered prospects; the decision of whether to consider the springs separately or as groups was based on expected energy potential, geographical proximity, geologic similarity, and known development plans. In addition, some areas of fairly certain geothermal resources were included,

TABLE 4

Potential Electrical Geothermal Prospects

Individual Possible Development Profiles

Roosevelt Hot Springs Prospect

Phillips Petroleum Co./Rogers International, Inc.
Thermal Power Co./AMAX Exploration, Inc./O'Brien Resources/VTN
Getty Oil Co.*

Cove Fort/Sulphurdale

Union Oil Co. (acting as unit operator)

Thermo

Republic Geothermal, Inc.

North Cove Fort

Caroline Hunt Trust Estate/Hunt Energy Corp.

West Cove Fort/Black Rock Desert

Chevron Resources, Inc.
AMAX Exploration, Inc.

*Later information indicates that Getty will probably not develop independently.

e.g., electrical prospects such as Cove Fort, Thermo, West Cove Fort, Beryl, New Castle, etc.

An essential part of defining resource areas is to match energy needs with the resources. The study did not progress far enough to complete this phase; it is of very high priority for the first part of the second year efforts. This process is outlined in detail in the discussion of direct use scenarios.

Direct use resource areas as delineated for the first attempt at scenarios are found in Table 5.

A more complete listing of potential areas is found in Table 6. These are areas of less apparent potential or less likely prospects for development. They are nevertheless potential use areas and should not at this point be disregarded.

TABLE 5

Potential Geothermal Direct Utilization Prospects in Utah
(Considered in Possible Development Profiles)

Monroe Hot Springs/Red Hill Hot Springs/
Johnson Hot Springs

Crystal Hot Springs (South Salt Lake County)

Wasatch Hot Springs/Beck's Hot Springs/
Hobo Hot Springs

Midway

Ogden Hot Springs/Hooper Hot Springs/
Utah Hot Springs (Including Ogden
area and Hill AFB.)

Meadow Hot Springs/Hatton Hot Springs

Joseph Hot Springs

New Castle

Cove Fort/Sulphurdale

Thermo

Tintic

Beryl

Abraham Hot Springs

West Cove Fort

Black Rock Desert

Veyo Hot Springs

LaVerkin Hot Springs

Crystal (Madsen's) Hot Springs

TABLE 6

Potential Geothermal Direct Utilization Prospects in Utah
(Not included in individual development profiles.)

Blue Warm Springs
Bothwell Warm Springs
Castilla Hot Springs
Como Warm Springs
Cultler Warm Springs
Diamond Fork Warm Springs
Fish Springs/Big Springs/Wilson Hot Springs
Gandy Warm Springs
Goshen Warm Springs
Grantsville Warm Springs
Lincoln Point Warm Springs/South Utah Lake
Little Mountain Warm Springs
Livingston Warm Springs
Morgans Warm Springs/Russells Warm Springs
Radium Warm Springs
Richfield Warm Springs
Saratoga Hot Springs/Crater Hot Springs
Split Mountain Warm Springs
Stansbury Mountains--Big Warm Springs,
Burnt Springs, Horseshoe Springs, Iosepa
Springs, Muskrat Spring
Sterling Warm Springs
Stinking Hot Springs
Uddy Hot Springs
Warm Spring

Other Potential Areas

Cache Valley
Uintah Basin
Wendover/West Toole County

From: Mundorff, 1970.
DOE Regional Hydrothermal Development Presentation, 1978.

POSSIBLE DEVELOPMENT PROFILES

A principal objective of the Operations/Research Study is to develop meaningful, specific "development scenarios" or "possible development profiles." This has been accomplished in part, and the groundwork has been laid for an on-going effort to update and improve the planning forecasts and to make them a powerful tool for planning.

In theory, the procedure for creating scenarios is to obtain information from the sources most directly involved, use the information to develop a scenario, then repeat the cycle by adding details, checking back with the sources, revising the scenarios, and so forth, continuing in an iterative process. The sources should be as direct as possible; e.g., the industries, agencies, and individuals actually involved. The process would thus provide current information to the study and develop strong working relationships not only between the study team and the various sources but also among the sources.

Unfortunately, much of the information needed to make the scenarios very specific is either proprietary or unknown. Most geothermal developers are hesitant to estimate such parameters as reservoir capacities, depths, and other characteristics, or to provide firm time frames for exploratory drilling. They are also unwilling to speculate very much about promising but not widely known prospects. This reluctance is justifiable since public access to this type of information would probably damage the individual company's

competitive position. Often, too, the company has not yet developed this information; a good example is reservoir capacity, which usually is not determined until the power plants have been in operation for many years. In effect, this means that by the time all the information is available, there is no longer a need for forecasting.

This lack of definitive information makes it necessary to use assumptions. Where professional assumptions or estimates were available, they were used; but the study team frequently found it necessary to specify its own assumptions. Such assumptions are very seldom comfortable and there is seldom a consensus where specific numbers are involved. In addition, it frequently happens that some information can be released; but the supportive data are proprietary, so that the information may be valid but to all appearances is unsupported. Of course, there is also an inescapable subjectivity associated with such assumptions which usually causes judgment to be to some degree personal rather than professional; this problem is in reality fundamental and has frequently become apparent in the course of the study, not only in the assumptions but also in critiques of the assumptions.

In spite of these drawbacks, it is necessary to use assumptions in developing the scenarios. The approach which was considered most appropriate was to gather the best available information, synthesize it to a concise and organized form, propose the assumptions, and document and explain them fully. The process would then be repeated by confirming that the

assumptions are reasonable through contacts with the best possible sources, incorporating their input, and continuing through successive iterations.

Process of Creating Development Profiles.

The first step in development of the possible development profiles was to analyze the lease data and describe the lease areas in terms of size, contiguity, location, proximity to major resource areas, distance from populated areas, and developer interest as indicated by exploratory activities on or near the leases. This extensive body of information provides a broad base of back-up data and will eventually be developed even more fully.

As more information concerning geothermal prospects was gathered, the development patterns began to take shape. The first attempts at scenarios were based primarily on the work done by the MITRE Corporation for the Department of Energy. As more information relating to current developments at specific sites, problems encountered at individual prospects, and further plans for development, etc., became available, it was compiled and assimilated.

The first attempt at a development profile for a specific prospect was for Roosevelt Hot Springs. Data acquired from the developers were used as the basis for the preliminary scenario, and some aspects were, of course, extrapolated from known information.

The preliminary scenarios were then analyzed to refine the information and the format, and similar scenarios were

developed for other prospects, with emphasis on those developments which appeared to be most advanced with respect to exploration.

Based on information available April, 1978, the following preliminary scenarios were developed:

Roosevelt Hot Springs Prospect:	Phillips Petroleum, Rogers International, UP&L. Thermal Power Co., AMAX Exploration, Inc., O'Brien Resources, and VTN. Getty Oil Co.
Cove Fort/Sulphurdale:	Union Oil Co., Unit Operator.
North Cove Fort:	Caroline Hunt Trust Estate.
Thermo:	Republic Geothermal, Inc.
West Cove Fort/Black Rock Desert:	Chevron Resources, Inc. AMAX Exploration, Inc.

The major assumptions for these scenarios were the presence of a commercial reservoir, economic advantage of development, and lack of institutional restraints. It must be remembered that the assumptions are an integral part of the development profiles.

After the preliminary scenarios were developed, the various developers were contacted by phone and a few key points in each individual development profile were discussed. The input from these discussions were incorporated into the scenarios, which were then sent to the various developers for comments and further input.

The development scenarios and the associated assumptions are found in Appendix B. Again it must be emphasized that

the assumptions are an integral part of the profiles and are as important as the schematic charts themselves.

It should be noted that most of the developers had few comments on the scenarios which were sent to them. This was apparently because (1) the charts were quite general and lacked a high degree of detail; (2) the assumptions were spelled out perhaps too restrictively to invite comment; (3) it is difficult to discuss this type of material over the phone. It is likely that personal discussion would invite more criticism of the assumptions--which is what is needed--than a phone discussion. Of course, many people are somewhat reluctant to criticize someone else's assumptions if they seem reasonable, even though they disagree with them.

Once the scenarios had been developed, they were aggregated into a state-wide "power-on-line" scenario. This scenario is shown in Figure 1; the assumptions follow the scenario.

Evaluation of Electrical Development Profiles

The scenarios in their preliminary form are felt to represent the best available, current information in light of the assumptions. A discussion of the limitations of the scenarios would be lengthy and tedious, but a few aspects need to be brought out.

One of the most limiting assumptions is that of a commercial reservoir and an energy capacity. There is a wide range of capacity estimates, mainly because no definite information is available, because there are a variety of purposes for the

Figure 1

Aggregated Scenario--Electrical Production from Geothermal Resources in Utah

	tot MWe	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
Roosevelt Prospect	400			50		50		50		50		100		100								
Cove Fort Sulphurdale	200					50		50		50		50										
West Cove Fort	200						50		50		50		50									
North Cove Fort	200						50		50		50		50									
Thermo	100							50		50												
Other Areas (Sevier Lake, Black Rock Desert, Delta Area	200								50		50		50	50								
TOTAL FOR YEAR				50		100	100	150	150	150	150	150	150	150								
CUMULATIVE TOTAL				50		150	250	400	550	700	850	1000	1150	1300								

Figure 1 (Continued)

ASSUMPTIONS USED IN SCENARIOS

April 1978

Roosevelt Hot Springs Prospect

1. The reservoir capacity at the Roosevelt Prospect was assumed to be 400 MWe. This figure is averaged between Phillips (1) and UP&L (2) planning estimates of 300 MWe, and Dr. Stanley Ward's estimate of 500 MWe (3). The heat flow data compiled by Dr. David Chapman also indicates about 300-500 MWe. In this respect 400 MWe is considered an optimistic and fairly realistic estimate.

2. According to Phillips and UP&L (1&2), the plants are planned to come on-line in 55 MWe units two years apart if feasible. The following assumptions were based on this information:

   A. The plants were generally assumed to come on-line two years apart.
   B. The later plants were assumed to be 100 MWe Plants. This presumes:
      (1) Adequate reservoir capacity.
      (2) Development by a single operator (unitization).
      It is possible that later plants might be 55 MWe plants on-line each year.

Cove Fort

1. Several factors will tend to retard development at Cove Fort (Sulphurdale).

   A. Drilling has been very difficult. It has taken a long time and considerable problems were encountered from a geological standpoint.
   B. Because of these problems with drilling, the wells drilled by Union have been very expensive.
   C. The presence of a viable reservoir has not yet been satisfactorily verified.

2. In spite of these setbacks, several ventures are proceeding (4). For purposes of the long-range scenario, the following separate ventures were assumed.

   A. Sulphurdale--Union could have two areas here, one north of the freeway, one south. Because Union still appears to be progressing, the first plant was assumed to come on-line in 1984. The sites are left unspecified. This is an optimistic forecast, particularly in light of the difficulties mentioned above.

Figure 1 (Continued)

B. North Cove Fort (Dog Valley)--Hunt Energy Corp. is currently drilling on private lands several miles north of the Sulphurdale area. An optimistic forecast would put them on-line about 1985 or, at best, 1984. Of course, the controlling factor will be the discovery of a reservoir.

C. West Cove Fort Area--Several groups are conducting intensive exploratory activities in this area, although no deep wells have been drilled. Developers in this area are AMAX, Hunt, Chevron, Phillips, and others. An optimistic estimate could place at least one of these prospects on-line in 1985 (4). Because several developers are involved, the plants could come on-line in bunches; the assumption for the scenario was usually a plant each year.

3. Reservoir Quantities: Based roughly on various estimates of reservoir capacity, the following quantities were assumed:

   Sulphurdale 200 MWe.
   North Cove Fort 200 MWe.
   West Cove Fort 200 MWe.

   These assumptions appear to be optimistic but reasonable. Sulphurdale, North Cove Fort, and West Cove Fort were assumed to have 200 MWe capacity each. Again, these capacities are not scientific reservoir estimates but are useful for purposes of estimating development patterns.

4. Federal Programs and other incentives/assistance: It was assumed that optimistic estimates would be partially justified by the development of federal initiatives to accelerate and assist development in Cove Fort areas. Such programs were left unspecified but will probably include case study programs, technology transfer, and the reduction of institutional restrictions.

   Note: Cascading and multiple use systems will very likely be developed for some of these areas, most particularly in the Sulphurdale area where exhaust from the power plant may be used in sulphur mining or other industrial operations (4).

Thermo Prospect

1. Reservoir capacity was assumed to be 100 MWe. This is a moderately optimistic assumption. The rationale for this estimate was that the area involved might be larger than the 1.5 km^2 estimated by USGS Circular 726, although at this time there is little evidence to support this hypothesis.

Figure 1 (Continued)

2. Earlier scenarios estimated drilling to begin at Thermo in 1980 (6). Republic Geothermal drilled a deep well in late 1977. This would seem to indicate that development at Thermo could be advanced by as much as two years. Also, federal programs could make an earlier production date feasible for Thermo as well as for some of the Cove Fort areas. On the other hand, preliminary information from the Republic Well at Thermo does not seem to justify boundless optimism; hence, the first plant was estimated to produce power on-line about 1986, with another 50 MWe plant following two years later.

Figure 1 (Continued)

References

1. Phillips Petroleum Co., Verbal and written communications, February and March, 1978.

2. Dr. Val Finlayson, Director of Research and Development, Utah Power and Light Company, Salt Lake City, Utah. Personal Communication, March 28, 1978.

3. Dr. Stanley H. Ward, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah. Personal Communication, March 28, 1978.

4. Kenneth Bull, U.S. Geological Survey, District Geothermal Supervisor, Salt Lake City, Utah. Personal Communication, April 4, 1978.

5. State and Federal Geothermal Leases, compiled by the Utah State Team, February, 1978.

6. MITRE Corporation, METREK Division, "Site Specific Analysis of Geothermal Development--Data Files of Prospective Sites." October, 1977.

projections, and because of differing interpretations of data which may or may not be public. In most cases the developers are more conservative in their capacity estimates, when they make estimates at all; consultants seem to be more optimistic in their estimates.

The Operations/Research personnel in some states have also been resource assessment personnel or had close access to them, but in other cases O/R personnel have been somewhat miscast in the role of resource capacity assessor.

The estimates used as capacity estimates are shown in Tables 7 and 8 . Table 7 contains the figures used for the DOE Regional Hydrothermal Development Plan, and Table 8 includes the figures used for the Operations/Research Scenarios. The primary difference between the estimates is that optimistic figures were used for the Regional plan, whereas for the Operations/Research project there was a need for assuming a specific capacity for a specific prospect and more conservative values were used. In some cases where no reservoir information was available a "reasonable default" figure of 200 MWe was used.

TABLE 7

ELECTRICITY GENERATION RESOURCE

(for 30 yrs >200° C)

	Proven Reserve (Measured) (MWe)	Potential Resource (Indicated) (MWe)	Inferred Resource (Geol-Geophys) (MWe)	TOTAL
Utah				
Roosevelt Hot Springs	100	200	200	500
Cove Fort Sulphurdale Black Rock Desert Thermo		500	1000	1500
Nevada				
Battle Mountain Heat Flow High		1000	2500	3500
New Mexico				
Valles Caldera	50	350	100	500
other Rio Grande Rift and Lightning Dock		200	800	1000
Idaho				
Eastern Snake River Plain			1000	1000
SUBTOTALS	150	2250	5600	8000
REGIONAL TOTAL			8000 MWe	

Undiscovered high grade reservoirs throughout the region may contribute an additional 8000 MWe.

From DOE/DGE Regional Hydrothermal Development Plan.

TABLE 8

Estimated Energy Capacities for Development Planning Profiles.

	Identified (MWe)	Indicated (MWe)	Inferred (MWe)
Roosevelt Hot Springs	100 (1)	200 (2)	200 (3)
Cove Fort/Sulphurdale		220 (4)	
North Cove Fort			200 (5)
West Cove Fort/Black Rock Desert			200 (5)
Thermo		20 (4)	80 (5)
Other Areas			200 (5)

(1) Estimate based on current plans by Phillips/Rogers/UP&L and Thermal Power/AMAX/O'Brien/VTN, each for a power plant on-line by 1982 at the Roosevelt prospect.

(2) Estimate for total power to 1983 from Roosevelt prospect by UP&L of 330 MWe (total: 312 MWe net output) for planning purposes.

(3) Additional potential to total of 500 MWe for Roosevelt prospect; estimate by Dr. Stanley Ward, also based on heat flow data analyzed by Dr. David Chapman.

(4) Estimates for electrical capacity at Cove Fort/Sulphurdale and Thermo Hot Springs of 221 MWe and 20 MWe for 30 years respectively, based on USGS Circular 726 and data analyzed by Chandler Swanberg and the Operations/Research Core Team at NMSU.

(5) Additional values for Cove Fort/Sulphurdale, North Cove Fort, West Cove Fort, Thermo, and other areas are default assumptions used for planning purposes. These are not scientifically based estimates but are assumptions, which appear optimistic but reasonable, to provide a framework for the possible development profiles. There are geologic indicators of potential resources in each of these areas, but the values for the capacity estimates are not based on these geologic indicators.

Forecasted Development

There is currently only one prospect in Utah where development is definitely planned, the Roosevelt Hot Springs prospect. Two power plants are planned for this prospect for 1982. One will be a combined effort by Phillips Petroleum (the unit operator), Rogers International, and Utah Power and Light; the other by a consortium formed by Thermal Power Co., AMAX Exploration, Inc., O'Brien Resources, and VTN, Inc. The Phillips group controls most of the land in the prospect because it holds most of the federal leases; the Thermal Power group controls several key sections of state land within the prospect. Unitization of the prospect is a possibility, in which case it is likely that only one plant would come on-line in 1982; another possibility is that the two groups could make a cooperative agreement and develop simultaneously and semi-independently; or the two developments could proceed completely independently from each other. At this time, both groups have expressed plans for independent development; therefore, the most prudent and diplomatic approach is to assume that both plants will come on-line in 1982.

Development at other sites is likely or possible, particularly Cove Fort/Sulphurdale and Thermo, where wells have already been drilled and where exploration is continuing, and where some information about the resource has been gathered. The North Cove Fort prospect, where the Hunt Energy Corporation is drilling, may also be developed. The other areas are either unknown or the information is confidential.

The most controlling factor in the development of these prospects will be the presence and characteristics of the reservoir. Of the three basic assumptions for the scenarios (commercial reservoir, economic advantage, and institutional cooperation) the reservoir capacity is more critical than the other two assumptions. However, it is the factor about which the least is known. Development will follow if, when, and where the commercial resources are found. The reason that this is significant is that to date, resources suitable for electrical production have been located only at the Roosevelt prospect -- in spite of exploratory efforts at several other sites.

As a result, all of the development profiles except for the Roosevelt prospect will be pushed back in time by the lack of discovery and will really not come into focus until the necessary resources are actually located.

The emphasis in the preliminary scenarios has been on the role of the developer. The involvement by other institutions, i.e., state and federal agencies, research groups, etc., has been analyzed on a general basis and is found in the discussion of institutional involvement.

Direct Utilization Development Profiles

Development associated with direct use application is more difficult to forecast than for electrical production. The reasons for this are varied: much more of the resource is suitable and available for use, so that prospects are much more numerous; development can occur much quicker and

on a much smaller level; a large number of uses are possible; location plays a much more nebulous role; potential developers are much more difficult to identify; and so on.

The initial thrust of the Operations/Research project in evolving development profiles was to identify existing known and potential resource areas. These areas included primarily hot springs areas; other areas of known or indicated hydrothermal resources, such as Beryl, New Castle, Tintic, and so forth, were also added.

Background data for the eventual development profiles were compiled through a process of gathering all available information on each prospect and summarizing it into prospect descriptions. The descriptions are found in Appendix B. A sample of a prospect description is given as Table 9. The sources of the data are also found in Appendix B.

Unfortunately, time restraints precluded the generation of detailed, meaningful direct use development profiles. The process which will be used to generate the profiles will be to match areas of energy demand to resource areas; this process, as now foreseen, will be described later in this section.

In lieu of the individual direct use development profiles, a very rough, very preliminary attempt at an aggregated scenario for the state was generated. Because of the short time involved, the lack of known plans for direct use development, the fact that much of the background data necessary for the

TABLE 9

Prospect: Monroe Hot Springs
(Also Red Hill, Johnson Hot Springs)

Resource Characteristics:

Surface Fluid Temperature: Monroe 76°C, Red Hill 77°C, Johnson's 25°C /6/

Subsurface Fluid Temperature: Monroe 120°C, Red Hill 135°C /1/

Total Dissolved Solids: Monroe 2750 ppm, Red Hill 2630 ppm, Johnson 428 ppm /6/.

Estimated Energy Potential: Monroe 38 MWt, Red Hill 43 MWt, Johnson 4 MWt for 30 years Total: 85 MWt /1/

Type of Overlying Rocks: Springs issue from tufa mounds along the base of the mountain/6/, grading west into alluvium in the valley.

Location of Prospect: Just east of Monroe, Utah; T25S, R3W, Sec. 11, 15, and 27 /6/.

Description: Series of hot springs issuing from hillside immediately east of Monroe City, at the base of a large mountain. The springs are along a north-south trending fault /6/.

Land Ownership: Mostly Private /2/. Some BLM and National Forest Lands east of the prospect /11/.

Land Use: Municipal, agricultural, range land, and forest land nearby.

Leasing: Some leasing in area. Limited leasing because most of the land is private/12/.

Activity:

The springs are presently being used by a spa for heating a swimming pool, showers, etc. The owners have expressed plans for eventually heating greenhouses and a motel complex.

The City of Monroe has received conditional approval on a proposal for a space heating system for the city. The first phase of this project would involve the heating of the South Sevier District High School; later the system would be expanded to heat homes in the city as well as several larger buildings in the city, a number of greenhouses, and several multiple unit complexes (motels and apartments).

direct use analysis had not been gathered (particularly industrial information), and some uncertainty about the proper procedure for developing the profiles, it was felt that at that point the individual scenarios would have been so speculative that they would not have been more meaningful than the rough aggregate. No attempt was made to forecast development of specific industries at specific sites. The approach used was to estimate a "curve of development" for each prospect or group of prospects. Although numbers were used to display this development, they are merely a rough, semi-informed estimate of the curve.

The aggregate scenario for direct use development is shown in Figure 2. This figure is a graphic version of the numerical aggregate found in Appendix B. The specific assumptions for each site are included as part of the prospect descriptions, which follow the aggregate in the appendix.

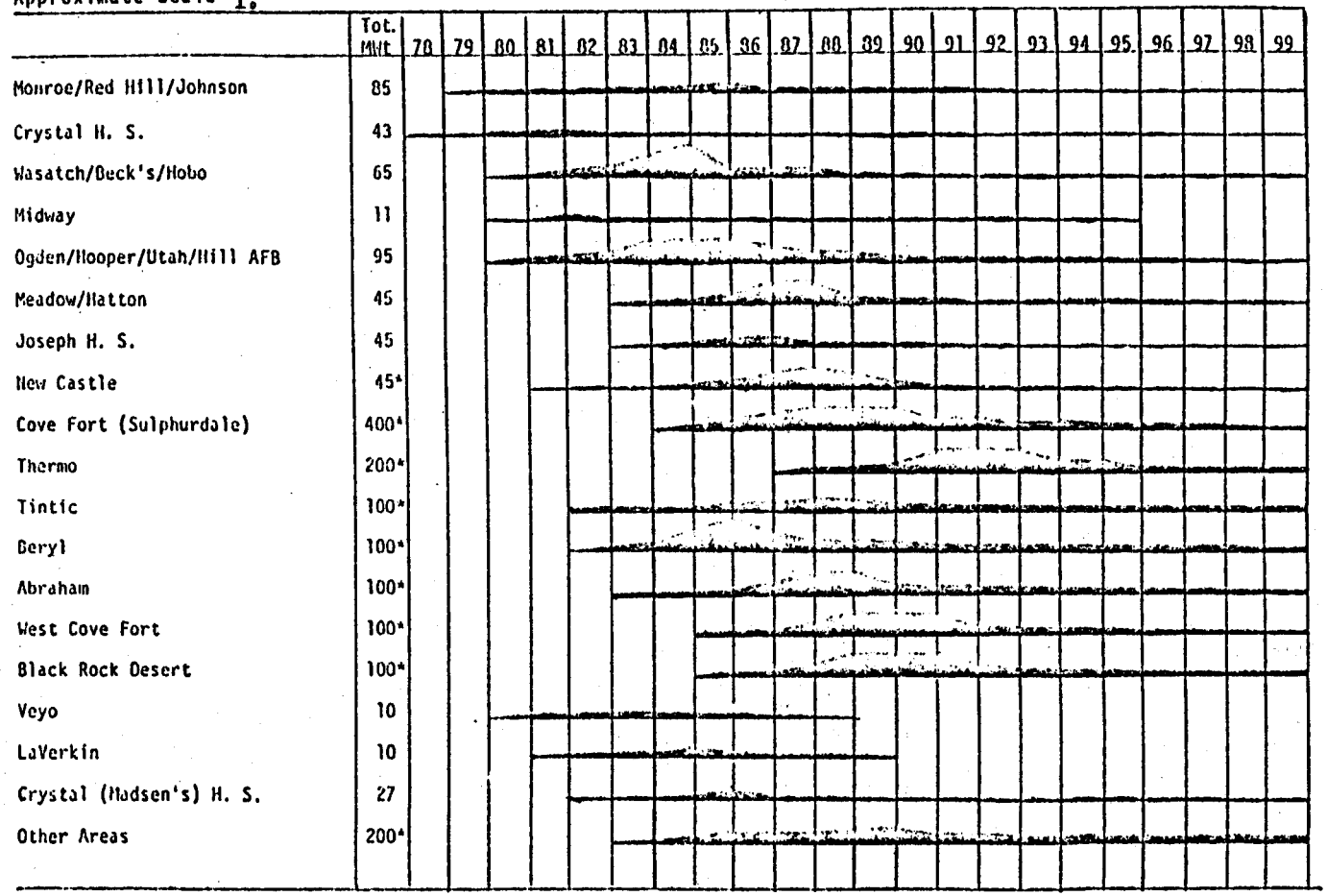
In some cases default reservoir capacities were simply assumed for areas of known or inferred resources where no indications of energy capacity were available. The purpose of these assumptions is not to estimate capacity but to take into account the presence of the resource. As data on temperatures and flow rate become available, estimates will be made.

Many of the spring areas and other areas were small in their estimated or assumed capacity and/or very remote. These springs and other prospects were grouped together in a

Figure 2

Postulated Geothermal Direct Use Development Profile for Utah
(New development each year, MWt)

Approximate Scale $I_{\circ}^{10MWt}$



* Default reservoir capacities assumed for planning purposes.

separate category, simply designated "Other Areas." A more complete list of some of the areas included in this category is found in Table 6.

Evaluation of Direct Utilization Development Profiles

For the reasons outlined above, the preliminary development profiles, as shown in the aggregate scenario, are not considered to be true forecasts but rather an estimate of the general pattern which might be expected for each area. Nevertheless, the background data as found in the individual data summary sheets are considered to represent a first but significant attempt to characterize the resource areas. The summary information is not complete nor up to date, since development occurs very rapidly. However, the summary sheets will provide a framework for a data file based on current information for each prospect or area.

Procedure for Specific Direct Utilization Profiles

A major priority for the second year's activities will be the generation of specific development profiles for lower and moderate temperature prospects. The following discussion outlines the general plan of procedure for developing the profiles, and generally follows the procedure developed by Barbara Coe of the Colorado State Team.

The first step has already been accomplished to a large degree -- that of cataloging and characterizing the resource areas in Utah. More data will be incorporated as they become available, especially from resource assessment studies.

Another major step will be to define energy uses and energy use areas. Various possible uses will be matched to the resource by location, temperature and quality of the resource, local potential for light or heavy industry, etc. An important part of this analysis will be the classification of the suitability of the resource for various potential uses. The objective will be to define as many potential uses as are foreseeable and to estimate the likelihood of development for each.

As the work of cataloging uses by area progresses, it will be important to establish contacts with those directly involved with the potential development. In cases of space heating, this would usually be communities; for other potential industries, such as mining, agricultural processes, greenhouses, institutional uses, etc., it will be much more difficult but nevertheless important to establish contacts.

The outcome of this research will hopefully be a delineation of development presently planned or under way, and also future or potential uses within the temperature and distance range of the resource area. When that has been accomplished, expert opinion will be sought as much as possible to estimate time frames for development.

The institutional analysis of direct use development is much more difficult because of the tremendous variability among individual projects. Nevertheless, an important part of the direct use development profiles will be a more detailed analysis of the institutional aspects involved, particularly

agencies, permits, legal problems, and recommendations. It is possible, for instance, that legal problems such as water rights will play an even more restrictive role in direct use development than in electrical development.

Forecasted Development

Direct use development can happen on a much smaller scale and hence much quicker than electrical development. As a result, direct use projects seem to pop up quickly and more and more frequently. A few firm plans are available; some rumors appear to be based on facts, but not firmly enough for publication.

The most firm plans at present involve the community of Monroe in central Utah, for which a DOE Program Opportunity Notice was granted. The project is a cost-share program whereby a large portion of the community will eventually be heated with geothermal energy, including houses, the South Sevier District High School, a church, the city hall and fire department, and a number of greenhouses, motels, and other commercial structures. The resource will be tapped by a well in the vicinity of the Monroe Hot Springs, run through a heat exchanger, and be reinjected on the opposite side of the fault from the springs area. The development is estimated to require about 1.07 MWt (3.2×10^{-5} Quads/year) (Monroe City, 1977), and the first phases are scheduled to be completed by about 1981 with expansion continuing beyond that date.

Plans for other developments are not so firm; in fact,

most are in the rumor stage. The Division of Water Rights has been approached by several developers who are applying for grants through the DOE Program Opportunity Notice program; it would probably be improper at this early planning stage to reveal much concerning them. Other inquiries have been made concerning small projects such as greenhouses and the heating of individual homes, but again, the plans are very preliminary.

In April 1978 the Utah Geological and Mineral Survey drilled some temperature gradient wells in the vicinity of Crystal Hot Springs, with financial assistance through the DOE State Cooperative Program. This led directly to the drilling of a geothermal well by the State Forester's Office, supposedly to be used for silviculture development. However, plans for this development may or may not have changed, or may change in a few weeks. Development in the area is fairly certain, but it is not completely resolved yet what that development will be.

ENERGY PRODUCTION AND CONSUMPTION IN UTAH

Utah is a state rich in energy resources. Some primary sources for energy in Utah are coal, hydroelectric, oil, natural gas, uranium, oil shale, tar sands, solar, and of course, geothermal resources.

Table 10 shows energy consumption, production, and net import or export in Utah for the years 1970-1975.

A major objective in the second year, as discussed in the section dealing with direct application scenarios, will be the identification of energy demands as related to the resource areas. This will require a much more in-depth analysis of energy production and consumption than is here given.

TABLE 10

Energy Production and Consumption in Utah, 1970-1975[1]
(Trillion BTU)

	Production					Consumption					Net Balance[2]	
Year	Oil	Natural Gas	Coal	Hydro	Total	Oil	Gas	Coal	Hydro	Total	Net Imports	Net Exports
1970	130.80	42.50	118.30	2.46	294.06	160.75	111.40	75.25	2.46	349.86	55.80	. . .
1971	132.30	43.60	115.70	2.60	294.20	181.24	109.70	74.83	2.60	368.37	74.17	. . .
1972	148.80	39.24	120.10	2.86	311.00	199.12	108.80	75.43	2.86	386.21	75.21	. . .
1973	183.00	42.50	137.50	3.13	366.13	205.88	114.30	98.93	3.13	422.24	56.11	. . .
1974	220.40	50.53	151.20	3.30	425.43	192.08	109.50	97.05	3.30	401.93	. . .	23.5
1975	224.10	52.53	172.50	3.56	452.69	201.60	109.60	83.20	3.56	397.96	. . .	54.73

1. Electrical consumption and production other than hydroelectric is assumed to be included in fuel consumption and so is not included in this analysis.
2. Does not include uranium.

From Millar and Searle, 1976.

ECONOMICS

No specific economic analyses or feasibility studies have been conducted by the Utah Operations/Research team, although such studies may be part of the second year's activities. Hopefully, the second year's efforts will include rough cost/benefit analyses of some of the more specific recommendations. More sophisticated economic and sensitivity analyses may be run by the Core Team at New Mexico State University using the computer models which they have developed.

Based on discussions with industry and others, a few conclusions may be drawn concerning geothermal exploration and development. One is that at this time geothermal development is not profitable enough to encourage industry to invest at a rate high enough to meet the postulated DOE goals; at least, exploration to date has been slow compared with original projections by DOE and others. There are several reasons why this is so. One is that front-end costs such as leasing and exploration, especially wildcat drilling, are very high. This is compounded by the fact that, at least in Utah, geothermal is still a fledgling industry. This increases costs because of such factors as the distance which drill rigs must be moved, the learning phase of drilling in any new prospect where initial drilling is expensive (such as Cove Fort), the need for geophysical/geological exploration at new prospects, as well as the high first-year rental for KGRA leases. All of these costs will decrease as development

proceeds, i.e., drill rigs will be available in the general area, drilling will be more effective and relatively less costly as the developers learn about the geology of an area and how to cope with local geological problems, etc.

The problem of high exploratory costs has been addressed in part by the DOE Industry Coupled Case Study Program, which provides direct financial assistance to the developer in return for the information gathered through the exploratory work. This program has been effective in Utah, where the Roosevelt and Cove Fort prospects were studied intensively, including partial funding (either directly or retroactively) for four deep wells at Roosevelt and three at Cove Fort/Sulphurdale. It is fairly clear that the program was effective in accelerating the new drilling; the funding of wells retroactively undoubtedly was of assistance to the companies involved, but the impact of the released information is less direct and hence more difficult to assess.

Another problem which adversely affects the economics of geothermal exploration and development is the existing tax structure. There are at present no tax incentives for geothermal exploration and development. If significant tax incentives were offered, both on the state and federal levels, it might aid in accelerating exploration and development. A depletion allowance is one possibility, but there are other methods of supporting exploration and development, both for electrical and direct use applications, perhaps by write-off advantages.

It may be that a basic problem is that geothermal development is in many cases still only marginally profitable. The basic role of the profit motive has been pointed out by several developers.

The economic problems associated with direct use development are not yet as evident as those associated with electrical development. There are some obvious problems, again associated with high front-end costs such as drilling and retrofitting. Again, it is not unreasonable to suggest tax incentives for small alternate-energy operations such as geothermal direct use applications. Another possible form of assistance might be a loan or loan guarantee program, if it were tailored to the needs of small and moderately sized developers. To be effective, the loan applications would have to be simple enough and approval would have to be reasonable enough to encourage small developers to apply.

INSTITUTIONAL ANALYSIS

A major objective of the Operations/Research study was to define and analyze the public and private actions necessary to bring geothermal development to pass. This objective, like the development profiles, will require successive iterations in order to refine and update the information.

The Utah O/R team approached the task of defining institutional involvement by obtaining information from developers (in particular Phillips Petroleum Co.) and approaching various agencies directly. With the preliminary information on the agencies involved and the permits required, a tabulation of the information was made. The various agencies were then contacted to verify and enhance the preliminary list. From this information another table of data was made, which included the various agencies involved, the stage of development at which the permit is required, approximately how long it takes for the permit to be issued, and a brief discussion of the permit and permitting process. This information is found in Table 11.

State Agencies

The primary geothermal regulatory responsibility within the Utah state government lies with the Division of Water Rights. This authority was granted by the state legislature in Section 73-1-20, Utah Code Annotated, 1953, included here in its entirety.

> 73-1-20. Geothermal energy production--Regulation by division of water rights.--(1) The

> division of water rights is given jurisdiction and authority to require that all wells for the discovery and production of water to be used for geothermal energy production in the state of Utah, be drilled, operated, maintained, and abandoned in such manner as to safeguard life, health, property, the public welfare, and to encourage maximum economic recovery.
>
> (2) In carrying out its responsibility under this act, the division of water rights may utilize personnel, equipment, or other assistance of any division or department and may transfer funds to that division or department to reasonably compensate it for use of its personnel or facilities.

The legislation is brief and general. The Division of Water Rights has drawn up working Rules and Regulations for Geothermal Wells and Exploration. These rules and regulations have not yet been adopted but are being used as drafted at this time.

A preliminary list of state and local agencies involved in geothermal development is found in Table 12. Most of these are not involved in a regulatory capacity. It is certain that as development progresses more agencies and groups will be involved. This list includes only those who have already interacted or who have been contacted by the Operations/Research study team.

It is evident that several of the agencies could go in different sections of the list. It is also apparent that the role of each respective agency will vary from development to development, and many of the agencies listed may be involved in several ways in any given development; for instance, the Department of Business regulation issues the

Table 11

Preliminary Assessment of Agencies and Permits Involved in Geothermal Development in Utah

	Permit	Required Prior To:	Estimated Time For Issuance	Notes
County Agencies				
County Planning Commission (1,2)	Zoning	Depends on county zoning ordinances	Variable	Already accomplished in some counties
County Clerk (1)	Business License	Sale of electricity		
County Commission or Health Department (1,2,3)	Health Code Enforcement Building Inspection	Use of buildings	Varies	
State Agencies				
Division of State Lands (4,5)	Lease State Lands	Exploration or use of lands	Few Days to 2-3 weeks	May be competitive bidding in some cases but that does not significantly increase issue time
	Special Use Permit	Surface disturbance (Construction of plant)	Not known--possibly about 2 months	Has not yet been applied for in Utah
Department of Transportation (6)	Encroachment Permits	Use of state highway lands for utility lines	Few days	Would be necessary for use of or crossing of State Highway Rights of Way with utility lines such as power lines, water mains, sewage pipes etc.
	Oversized Vehicles Permit	Use of highway for oversized vehicles	About a day	
Division of Water Rights (7,8)	Permits for Thermal Gradient Wells	Drilling of thermal gradient wells	Few days to few weeks	Letter of approval
	Permit for Exploratory "Test" Wells	Drilling of exploratory wells	Few days to few weeks	Letter of approval

	Permit	Required Prior To:	Estimated Time For Issuance	Notes
Continued from:				
Division of Water Rights (7,8)	Notification of Reservoir Test	Reservoir tests		
	Appropriation of Water	Use of water	6 months or longer	May depend on how fast the developer wants approval
	Production and Injection Wells			Covered by Appropriation of water if included in the Plan of Operations
Environmental Health Services				
Bureau of Water Quality (3)	Construction Plan Review and Permit	Construction	About 2 months	Pre-planning workshop
	Public Water Supply Approval	Use of building	1 to 2 months	
	Draft and Certification of Discharge Permit (Sanitary)	Use of building	1 to 2 months	In conjunction with EPA which issues the permit
	Liquid Waste Disposal System Approval	Use of building	1 to 2 months	
Bureau of Air Quality (9)	Construction Plan Review and Approval	Construction	About 3 months	In conjunction with EPA
	Discharge Permit	Use of plant	About 3 months	Plant discharges
Bureau of Solid Waste Management (3)	Solid Waste Disposal			
Department of Business Regulation (10)	Certificate of Convenience and Necessity or Approval of Contract Between Utility and Electricity Producer	Sale of Electricty	3 to 4 months	Certificate of convenience and necessity if utility owns plant; if utility buys power, approval of contract is required

	Permit	Required Prior to:	Estimated Time For Issuance	Notes
Federal Agencies				
Bureau of Land Management (11,12,13)	Permit for Pre-Lease Operations	Non-surface disturbing exploratory activities on lands not leased by applicant	30 days	Includes geophysical/ geological exploration, temperature gradient surveys, etc., 30 day time limit for approval
	Issue Lease--BLM Lands			
	Conducts EAR Conducts KGRA Lease Sales Issues Lease		About 5 months Total: about 8 months (up to 18 months in Utah)	
	Plant Siting Permit	Plant Construction	Not known	None Approved yet
	Post-Lease Joint Approval with USGS of Plans of Operation			Site specific
U.S. Forest Service (11,12)	Special Use Permit for Pre-Lease Operations	Before exploratory activities on lands not leased by applicant	30 days	Includes geophysical/ geological exploration, temperature gradient surveys, etc., 30 day time limit for approval
	Issue Lease--Forest Service Lands	Before major exploratory activities	About 17 months or longer	Lease obtains rights to the resources
	Conducts EAR KGRA Land Sales Approves Lease			
	Joint Approval with USGS of Plans of Operation			

	Permit	Required Prior To:	Estimated Time For Issuance	Notes
U.S. Geological Survey	Administers Terms of Lease			
	Approves Permit for Exploratory Activities	Before non-surface disturbing activities	30 days	Includes geophysical/ geological activities, temperature gradient surveys, etc., 30 day time limit for approval
	Conducts Site-Specific Environmental Analysis and Approval of Plans of Operation			Plans of operation are site-specific
	Exploration	Before surface-disturbing activities	About 1 year	
	Environmental Baseline Data	Gathering of required 1-year's environmental baseline data	About 3 to 5 months	Must be completed at least one year before Plan of Production is submitted
	Development	Drilling and development of production wells	About 3 to 5 months	Define extent of field
	Injection	Drilling and development of injection system	about 3 to 5 months	
	Utilization	Construction of power plant	about 3 to 5 months	Sundry notices submitted for each phase. Includes contract and royalty breakdown.
	Production	Use of the resource for power production	about 3 to 5 months	Includes production data from wells and target date for completion
	Changes in Plans of Operation	Before implementation of changes in plans of operation	A few months	Sundry notices

	Permit	Required Prior To:	Estimated Time For Issuance	Notes
U.S. Environmental Protection Agency	Certify Air Discharge Permit		About 90 days	Air, water, solid waste permits are in conjunction with State Environmental Health Agencies.
	Issue Water Permit		About 90 days	
	Issue Solid Waste Disposal Permit		About 90 days	
	Review of EIS			
U.S. Fish and Wildlife Service	Advisory			Consults on lease sales (competitive and non-competitive), pre-lease and post-lease environmental analyses.
U.S. Department of Energy	Financial Assistance			
	State Cooperative Program		About nine months	
	Industry Coupled Case Study Program		About nine months	
	Loan Guarantee Program			
	Demonstration Programs			
	Development of Lease Stipulations			
	Issuance of Lease			

REFERENCES TO TABLE 11

Preliminary Assessment of Agencies and Permits Involved in Geothermal Development in Utah.

1. Chad W. Johnson, Beaver County Commissioner, Beaver, Utah. Personal communication, June 14, 1978.

2. Delaine McGarvey, Davis County Health Department. Personal communication, June 13, 1978.

3. Marvin H. Maxell, Ph.D., Environmental Health Scientist, Utah Bureau of Water Quality, Salt Lake City, Utah. Personal communication, May, 1978.

4. State of Utah, Rules and Regulations Governing the Issuance of Mineral Leases, issued by the Board of State Lands.

5. Donald G. Prince, Assistant Director, Division of State Lands, Salt Lake City, Utah. Personal communication, June 14, 1978.

6. Utah Department of Transportation, District 2, Encroachment Office. Personal communication, July 6, 1978.

7. State of Utah, Rules and Regulations of the Division of Water Rights for Wells Used for the Discovery and Production of Geothermal Energy in the State of Utah. March 1, 1978.

8. Stanley Green, Directing Appropriations Engineer, Utah Division of Water Rights, Salt Lake City, Utah. Personal communication, June, 1978.

9. Lynn Menlove, Public Health Engineer, Utah Bureau of Air Quality, Department of Social Services, Salt Lake City, Utah. Personal communication, May, 1978.

10. Ray L. Pruett, Utility Service Engineer; Clayton S. Hogstrom, Utility Rate Engineer; Victor N. Gibb, Real Estate Subdivision Inspector; Utah Division of Public Utilities, Department of Business Regulation, Salt Lake City, Utah. Personal communications, February 23 and June 23, 1978.

11. Kenneth Bull, District Geothermal Supervisor, U.S. Geological Survey, Salt Lake City, Utah. Personal communications, February to July, 1978.

12. Interagency Geothermal Streamlining Task Force, "Programs and Objectives of the Interagency Geothermal Streamlining Task Force" and associated information, June, 1978. Presented at Streamlining Workshop, Salt Lake City, Utah June 29, 1978.

13. Geothermal Steam Act of 1970 and Regulations on the leasing of Geothermal Resources. Published by the U.S. Geological Survey, U.S. Department of the Interior.

14. Draft Regional Hydrothermal Development Plan, Rocky Mountain/Basin and Range Region. Presented at Workshop, June 28, 1978. Material cited was explained at the workshop.

TABLE 12

State and Local Agencies and Groups
Involved in Geothermal Development

"Direct" Involvement

Utah State Legislature
Division of State Lands
Division of Water Rights
Bureau of Water Quality
Bureau of Air Quality
Bureau of Solid Waste Management
Department of Transportation
Department of Business Regulation
Utah Tax Commission
County Commissions
County Clerks
County Health Officers
County Tax Commission

"Advisory" or Consulting

Utah Geological and Mineral Survey
University of Utah Research Institute (UURI)
EG&G (Idaho Falls)
Utah Division of Water Rights
Various Consulting Firms

"Indirect" Involvement

Utah Energy Office
Utah Farm Bureau
State Building Board
Department of Development Services
Industrial Development Division
Office of Legislative Research
Foresters Office
Division of Oil, Gas, and Mining
Division of Health
Utah Department of Agriculture
Water User's Association
State Court System
Environmental Groups
Municipalities and Communities
Division of Wildlife Resources
State Planning Office

Certificate of Convenience and Necessity for a utility-owned power plant, and also issues carrier licenses to tank trucks which carry water to geothermal drill rigs. Of course, this type of complex involvement is very common.

A schematic diagram of the Utah State Government is shown in Appendix C. The path of authority for the Division of Water Rights and a schematic procedural flow diagram for the appropriation of water are also shown in Appendix C.

Analysis of State Institutional Factors

At this time, the institutional analysis for the state of Utah is only preliminary. Many unforeseen problems will undoubtedly arise, particularly with respect to direct use applications. Electrical developers are large and have done much advance research into potential institutional impediments; on the other hand, the smaller developers associated with many direct use projects often start from scratch and tackle problems as they arise. The result is that much of what is learned about institutional impediments to direct use comes from experience.

For electrical development, the major, foreseeable, possible impediments at the state level appear to be associated with water rights. This is not to say that water rights will be a problem, but that they appear most likely to be major, relative to other state requirements. Legal problems concerned with priorities of rights may arise as development progresses, particularly where the

ground water reservoir is connected to the geothermal reservoir. In prospects where several developers are drawing from the same reservoir, priority problems may also arise; however, at present it appears that these problems may take the form of unitization problems. This particular problem is as much an industry problem as a state problem, because it is based at least in part on administrative decisions by the involved developers.

A Unit would be formed at any particular prospect in order that the resource would be developed in a reasonable and beneficial manner. The advantages of unitization are numerous: orderly development, development based on the most advantageous geologic conditions rather than inter-lease competition, avoidance of water-rights disputes, sharing of costs and data, etc. The primary drawback is apparently that developers other than the unit operator are not able to fully determine development on their own leases. Federal regulations require unitization on federal lands.

The Utah Geothermal Rules and Regulations state:

> 2-6 Unit Agreements: At the request of any interested party or on his own initiative, the State Engineer may establish a unit plan or agreement for a geothermal area to prevent waste, protect correlative rights, and avoid drilling unnecessary wells. Proper notice to interested parties must be given and a hearing held before the State Engineer before the unit may be created.

It has not yet been determined by a court of law if the State Engineer does actually have the authority to enforce unitization; hopefully the question can be determined without lawsuits.

While it is foreseeable that legal actions could be taken if, for instance, unitization was enforced by the State Engineer, they could also arise if no unitization took place, e.g., legal struggles for the use of the water in a limited geothermal reservoir. The answer, of course, is voluntary unitization; but that is, as mentioned earlier, an administrative decision by the developers involved.

For direct use projects, water rights will also be a problem, but probably not for the same reasons. It appears that many low temperature basins are either connected to ground water basins or surface features such as springs or hot pots, where water is already appropriated. In some cases, it may be possible to use the geothermal water for heat and reinject it, but water required for other uses associated with the development may not be open to appropriation (it may still be available by purchase); in other cases, where hot springs are already being used for developments (usually spas), any withdrawal of the hot water may be protested. Potential problems are numerous; unfortunately, conflicts of this type are most likely to occur in the more populated areas, i.e., the Wasatch Front, where both population and resources are located but where most of the available gound water has already been appropriated.

There are, of course, other problems on the state level. Most of these involve lack of clarity of roles, overlap of responsibility, lack of clarity in some regulations, etc. Many of these problems exist because geothermal development is new in the state and it will take some time to sort out

responsibilities, make decisions on the most reasonable approach to regulations, and so forth. Most of these are not impediments as much as they are just a hassle, and many will be worked out in time.

An extensive and in-depth analysis of state laws, statutes, legislation, etc., coupled with workshops involving legislative bodies in each of the western states, has been undertaken by the National Conference of State Legislatures (NCSL). The purpose of this project is to aid the various states in analyzing existing institutional situations and in defining needed legislative changes, additions, and deletions, and then to act as advocate for the needed legislation. Utah has been chosen as a pilot state for the project; workshops will begin in August of this year. It is to be hoped that the O/R research and the NCSL Geothermal Policy project will be able to assist the states to define and prevent some of these problems before they arise.

Federal Agencies

The federal leasing and permitting system is very complex and often cumbersome. Leasing procedures were discussed on a general level in the section on leasing in Utah. This report will not deal with all the details of the federal leasing and permitting system; however, in order to define the perceived problems it will be necessary to discuss certain aspects in some depth.

The federal geothermal leasing and permitting system is administered primarily by the BLM and USGS in the Department of Interior, the U.S. Forest Service in the Department of Agriculture, and the Department of Energy. These agencies interact in various phases of the leasing/permitting process, and, under interagency cooperative agreements, each agency performs specific functions. Table 13 shows in brief summary form the various roles and interactions of the different agencies. Figures 3 and 4 show simplified flow diagrams of pre- and post-lease activities.

The federal leasing procedures have already been discussed in the section dealing with leasing in Utah. A complete, detailed discussion of the federal regulations, procedures, and practices would be volumous and beyond the scope of this particular report. The emphasis here will be on those aspects of the leasing procedure which are related to recommendations.

TABLE 13

Summary of Responsibility in the
Federal Geothermal Leasing and Permitting Program

BLM - Bureau of Land Management
DOE - Department of Energy
FS - Forest Service
FWS - Fish and Wildlife Service
GS - U.S. Geological Survey
IGCC - Interagency Geothermal Coordinating Council

Land Management Planning	BLM/FS
Pre-Lease BLM Exploration Permit or FS Prospecting Permit	BLM/FS (Primary) GS and FWS (Consulting)
Competitive Lease Sale Scheduling	BLM/FS/ GS/Industry/ IGCC
Pre-Lease Environmental Analysis	BLM and/or FS (Primary) GS and FWS (Consulting)
Competitive Lease Sales	BLM (Primary) FS/GS/FWS/DOE (Consulting)
Non-Competitive Lease Applications	BLM (Primary) FS/GS/FWS (Consulting)
Scheduling for Non-Competitive Leasing	BLM/FS (Primary) GS/FWS (Consulting)
Development of Lease Stipulations	BLM/FS/GS/DOE
Issuance of Lease	BLM/DOE
Post-Lease Environmental Analyses	GS (Primary) BLM/FS/FWS (Consulting)
Post-Lease Exploration Permit	GS (Primary) BLM/FS/FWS (Consulting)

Information presented by the Interagency Geothermal Streamlining Task Force, June 1978.

FIG. 3

EXISTING
GEOTHERMAL REGULATORY PROCESS
Principal Pre-Lease Activities

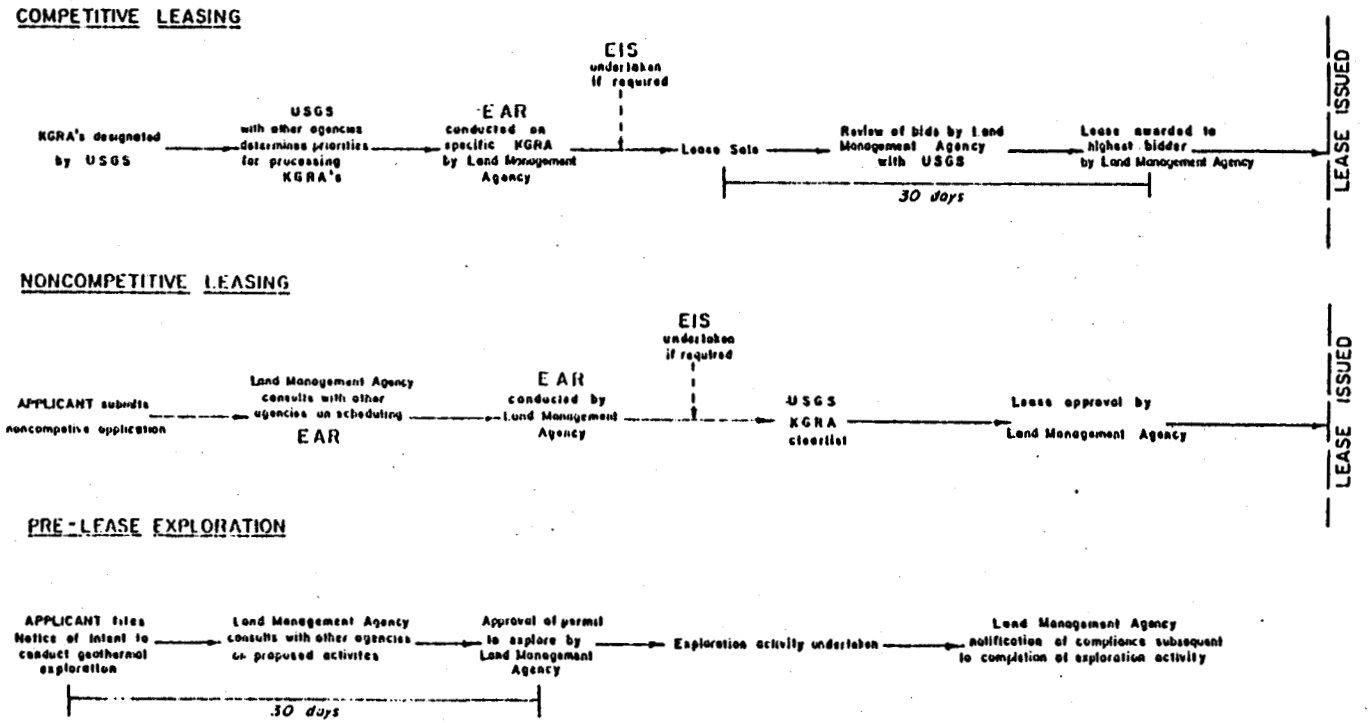
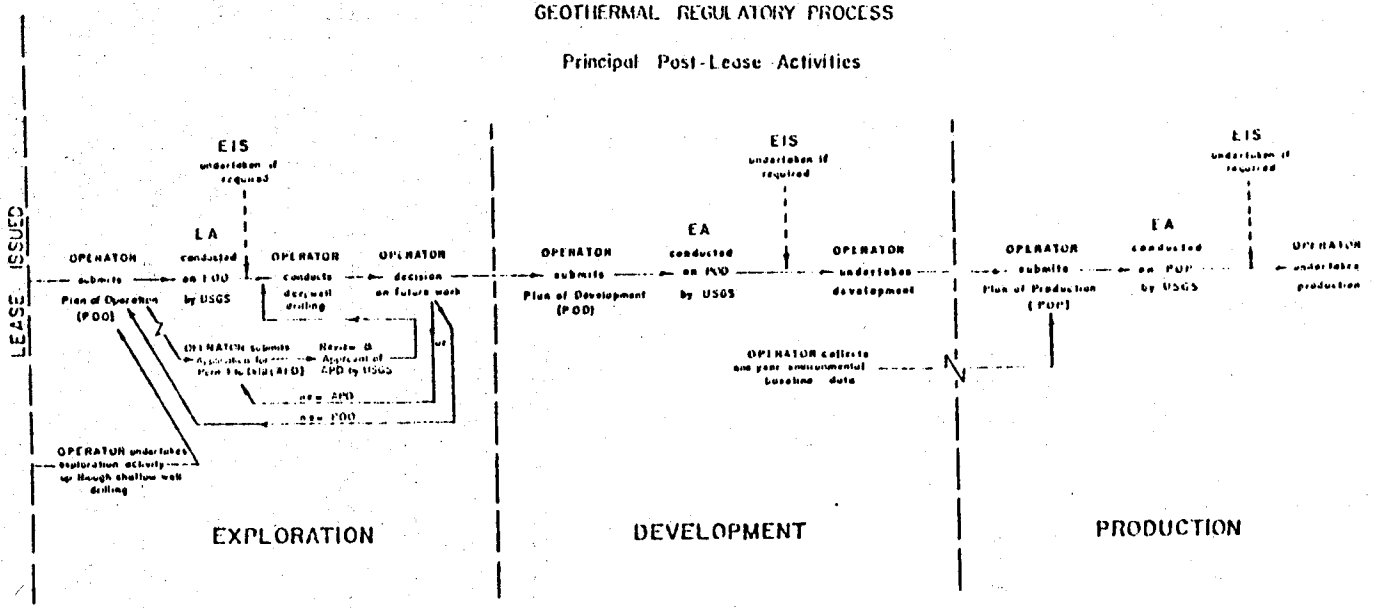


Fig. 4

EXISTING
GEOTHERMAL REGULATORY PROCESS

Principal Post-Lease Activities



Pre-Lease Exploration

Pre-lease exploratory activities such as geological/geophysical surveys or temperature gradient surveys may be conducted on federal lands under a casual use permit (BLM) or special use permit (USFS). Application is made to the surface management agency, which then has 30 days to approve the permit or explain to the applicant why it was rejected.

Competitive Leasing

Known Geothermal Resource Areas (KGRA's) are determined by the three methods mentioned earlier: geologic indications of resources, nearby discoveries, or competitive interest (other indicia may also be used). Competitive interest is defined basically as simultaneous filing for the same land. (Details are found in the federal regulations § 3200.0-5.)

If an area is designated a KGRA for geologic reasons or because of proximity to a discovery, the USGS in consultation with the other agencies determines the priority of processing the KGRA. An environmental assessment (EAR) is conducted on the specific lands in the KGRA by the surface management agency, usually either BLM or Forest Service. If the EAR indicates that an Environmental Impact Statement is necessary, it is conducted; if none is required, the results of the EAR are used to determine the lease stipulations. Input to the stipulations is provided by the other agencies, specifically by the USGS and the surface management agency.

The lands are then put up for sale and are advertised

by the BLM. Bids are received and reviewed by the surface management agency and the USGS. The lease is then awarded to the highest bidder by the surface management agency and the lease is issued by the BLM.

At present, there are no methods for declassifying lands from KGRA status. This means that the lands remain classified as KGRA even if no bids are received, and that subsequently they must be leased competitively regardless of the true industry interest or geothermal potential.

Non-Competitive Leasing

If a developer files for a lease on non-KGRA lands, and no other applications for the same land are filed within the same leasing period, the lease is processed as a non-competitive lease. Even so, the lease is not cleared as non-competitive until near the end of the approval process. Thus, an application which began as a non-competitive lease may be declared competitive before it is issued.

When an application for a non-competitive lease is submitted, the land management agency (usually BLM or USFS) consults with other agencies to schedule the EAR. The EAR is then conducted by the agency, and it is determined if an Environmental Impact Statement is necessary. The findings of the EAR or EIS are incorporated into the lease stipulations. Under current procedures, the lease is then sent to the regional USGS office where it is checked against the KGRA list. If it is at that time not KGRA land, it is sent back to the surface management agency for approval, and the lease is

issued by the BLM. Currently in Utah, it takes five months or longer for the EAR (probably longer on forest lands) and about three months for the subsequent administrative work; altogether a lease may be obtained in about eight months if no problems arise (Bull, 1978).

Post-Lease Permits

After the lease has been issued, the developer may obtain a permit for casual use (geological/geophysical exploration, temperature gradient wells, etc.) from the USGS. This post-lease exploration permit must be issued within 30 days, or the applicant must be informed why it was denied.

To obtain a permit for surface disturbing activities such as deep exploratory wells, the developer must apply by submitting a plan of exploration. The plan of operation must be fairly detailed and complete. Because of the long lead time for approval of plans of exploration, about one year (Bull, 1978), it is the usual practice by developers to apply for the maximum number of sites, i.e., exploratory wells, which are expected to possibly occur. The approvals apparently do not take significantly longer for a larger number of sites.

When the plan of operation is submitted, the USGS sends interested parties letters by way of announcement. Field investigations are then conducted and public comment is invited. The EAR's are carried out on a site-specific basis, i.e., proposed drill pad by drill pad. The results of the EAR's are incorporated into the stipulations attached to the

lease as conditions of approval. The plan of operation, with the stipulations, etc., is then submitted to the surface management agency and the USGS area supervisor for approval. The permits are then issued.

This procedure is carried out for each step of development. The various plans of operation which must be submitted are for exploration, development, injection, utilization, and production. (For explanations of the plans, see Table 11.) The plan of exploration is estimated to take about a year for approval, as mentioned above; subsequent plans may be approved in three to five months because much of the necessary information would be available from previous EAR's (Bull, 1978).

Other Federal Involvement

As seen from Table 11 and Table 13, other federal agencies involved in geothermal leasing, permitting, and development include the U.S. Fish and Wildlife Service, the Environmental Protection Agency, and the Department of Energy.

The U.S. Fish and Wildlife Service acts primarily as a consultant to the USGS and the other agencies. The Environmental Protection Agency is only remotely involved in the leasing and permitting process, but acts cooperatively with state and county health agencies for air and water discharge permits.

The Department of Energy acts somewhat as an advocate for geothermal development. It is involved in the development of lease stipulations and in the issuance of the lease.

The DOE also initiates programs to encourage geothermal development; i.e., case study programs, demonstration programs, loan guarantees, etc.

The Interagency Geothermal Coordinating Council was formed to promote coordination and cooperation between federal agencies. It plays an important role in simplifying procedures and reducing institutional impediments at the federal level, as discussed in the following section.

Analysis of Federal Involvement

It is generally agreed that federal regulations, procedures, and requirements impose significant encumbrances on geothermal development. Much of this impedance takes the form of delay in leasing and permitting; other impedance takes the form of restrictive stipulations or deliberate inaction on applications.

The Interagency Geothermal Coordinating Council (IGCC) represents virtually all the federal agencies which have anything to do with any phase of geothermal development. The purpose of the council is to coordinate geothermal-related activities by the member agencies. As a result of work by the council and other agreements, such as interagency memorandums of understanding, the leasing and permitting processes have been simplified somewhat by a reduction in the number of agencies with whom a developer must deal directly. (The other agencies may still be involved in the approval process.)

In spite of these preliminary efforts, the approval processes have remained cumbersome and slow. The IGCC was given

a mandate:

> "for assessing legal, environmental, regulatory, and other aspects of Federal, State, and local government policy as they relate to geothermal energy and for developing recommendations for changes and improvements in related laws, policies and procedures, and for examination of other institutional aspects of geothermal energy, including non-governmental aspects." (Interagency Streamlining Task Force, 1978.)

To assist the IGCC in this task, the Interagency Geothermal Streamlining Task Force was formed. The purpose of the Task Force is to develop specific recommendations to "streamline leasing and environmental review procedures to remove unnecessary barriers to development of geothermal resources" (Interagency Geothermal Streamlining Task Force, 1978). The Task Force has developed proposals and held workshops at several locations throughout the western states in order to collect public input on the recommended changes and improvements, as well as on problems and suggestions not covered by the proposals.

The result of this concentrated effort has been that most of the problems related to geothermal leasing and permitting on the federal level have at least been identified. This includes most of those identified as impediments by the Utah O/R team in the course of interviews and contacts with industry and governmental agencies.

One of the most consistently voiced concerns has been that of the general time lags involved in the federal procedures, both pre- and post-lease. The Streamlining Task Force has gone into considerable detail to define the areas where

unnecessary time lags occur, and has made a number of specific recommendations to correct these conditions. A summary outline of these preliminary proposals, which were drafted by the Task Force for the purpose of inviting comment, is found in Table14; the complete Task Force Program and Objectives, with supplementary information distributed by the Task Force, is found in Appendix E.

As part of the effort to aquire public input to the recommendations and proposals, a workshop was held in Salt Lake City, Utah, on June 29, 1978, which was attended by representatives of the O/R teams from most of the states included in the original Southwest Region; i.e., Colorado, Nevada, New Mexico, and Utah. (Arizona representatives were not able to attend.) The result of this meeting was that specific recommendations were made by the states in support of the Task Force proposals. These recommendations are summarized in Table15.

One subject which was not brought to issue by the task force was that of acreage limitations of federal leases. As explained earlier, there is a limit of 20,480 acres for any single developer within any given state.

The consensus among the industry contacted by the Utah O/R team was that the acreage limitations are not reasonable and form a barrier to accelerated geothermal development. The rationale for the acreage limitation was that it would encourage a wide spectrum of developers, including speculators, and that this would spur geothermal development. This was

TABLE 14

Outline Summary of Options for Modification of the Federal Geothermal Leasing and Permitting Program. (Preliminary proposals for purposes of discusssion.)

Option I

Improve the present system through changes in regulations and administrative procedures.

A. Use regional or areawide environmental analyses in pre-lease review and conduct site specific studies only during the post-lease permitting process.

B. Set time limits or timeframes (through administrative directive and/or regulations) for issuance of leases and permits.

C. Improve coordination in all phases of pre- and post-lease activities.

D. Improve uniformity and consistency of policies and procedures with respect to lease stipulations among the involved agencies.

E. Institute formal nomination procedures for KGRA's and non-competitive areas.

F. Allow no-surface-occupancy leases in wilderness study areas and other special areas where requested.

G. Modify KGRA regulations.

H. Allow issuance of non-competitive leases unless the area is in a KGRA at time of application.

I. Provide budgets in proportion to workloads, organizational needs, and priorities.

Option II

Base leasing decisions on areawide environmental assessment in combination with land management plan.

Option III

Provide for separate environmental analysis of exploration and development phases, with initial review of exploratory impacts only and comprehensive review only after a discovery is made.

TABLE 15

Summary of State O/R Recommendations:
Interagency Geothermal Streamlining Task Force Proposals

1. The states supported the three options proposed by the Task Force.

2. The states encouraged the elimination of competitive KGRA's. The competitive bidding system on KGRA lands was considered unreasonable, counter-productive in terms of benefits to the country, and an unnecessary barrier to geothermal development.

3. The states supported different methods of dealing with development of electrical versus non-electrical prospects. It was felt that the fundamental differences between direct use and electrical production warrant differences in regulations and administrative procedures.

4. The state teams generally supported Option III of the plan, which dealt with phased environmental studies, with the stipulation that the option be left as an elective choice open to the developer. It was also considered important that some sort of reimbursement be made available to the developer if substantial investments were made for exploratory work but further development was denied as a result of the comprehensive "second stage" environmental studies. This reimbursement could take the form of tax advantages, direct subsidies in whole or part, deductions from rentals for other leases, etc. It was also considered equitable that if a decision to deny development were later reversed, the original applicant should have priority in being able to develop the area.

5. Although it was not part of the Task Force proposal, it was felt that some states would benefit by having a geothermal consultant at the state level, possibly funded in part by the DOE. This individual could provide information services to the public and to the state governments, serve as an advisor to the state government (particularly the legislature), act as a liaison between the state, federal agencies, and industry, and perform other tasks to foster geothermal progress within the state.

6. Another recommendation by the state teams, which applied more to the states than federal agencies, was that the states should allow municipalities to incorporate as energy distributors, in order to allow for the use of geothermal energy on a community basis.

TABLE 14

Outline Summary of Options for Modification of the Federal Geothermal Leasing and Permitting Program. (Preliminary proposals for purposes of discusssion.)

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6. Another recommendation by the state teams, which applied more to the states than federal agencies, was that the states should allow municipalities to incorporate as energy distributors, in order to allow for the use of geothermal energy on a community basis.

supposedly based on experience with oil, gas, and hydrocarbon exploration.

However, as geothermal exploration has proceeded, a few problems have come into focus. For one thing, the oil, gas, and hydrocarbon lease limits within any single state is 246,080 acres, more than twelve times the 20,480 acre geothermal lease limits (BLM Public Relations Office, 1978). Furthermore, small speculative developers seldom have enough financial backing to do their own exploratory work. (There is only record of two exploratory wells--one of which was a temperature gradient hole--drilled by individuals in Utah.) The speculators apparently do not intend to do exploration work on their own, but rather seek to lease likely prospects and then sublease or assign the lease to a major developer who has the capability for exploration. This may distribute the wealth among speculators, but it does not encourage development; in fact, it impedes development by further burdening the developers, who actually do the work.

If the speculative lessees do not assign the lease, the odds are against development. If the lease is assigned to a major developer who can do the exploratory work, the acreage applies to the total for the developer, and is subject to the limitations. The net effect is that the developers frequently must make decisions whether to keep leases or drop them, without being able to do enough exploration to justify the decision.

The recommendation of the Utah O/R team is that lease limits be re-evaluated. The degree of impedance due to lease

limitations is, quite frankly, not clear at all. However, it appears that modifications are justified. Such modifications might involve simply raising the limits; exempting some lands from the state total in a manner similar to the exemption for unitized lands, e.g., lands where significant exploration has taken place; or other alternatives.

An essential element of any efforts to accelerate geothermal development will be tax incentives, on both state and federal levels. Geothermal tax provisions are currently pending in a House/Senate conference committee. The tax provisions, which are long overdue, should help alleviate some of the financial pressure on the developers.

Private Industry Involvement

Private industry, of course, plays a fundamental role in geothermal development. It is really at the industry level that decisions are made as to whether the potential benefits, both long and short term, justify the expenses of exploration and development. Administrative decisions within an industry, often based on data unavailable outside the company, can drastically affect the rate or extent of development at a given prospect or over a given area. Development is usually directly dependent on the industries' ability to interpret geological information in order to locate resources.

The major developers in Utah, as indicated by exploratory wells (mostly temperature gradient wells) are shown in Table 16. Most of these developers are oil exploration companies. Some of them, such as Hydrosearch and Utah Power and Light, tried a few ventures several years ago and have not done much exploratory work since. The utilities which have shown interest to date are also listed; of course, Utah Power and Light is by far the major electrical utility in Utah. Also shown are a number of potential direct use projects which at this time seem most likely to be developed; however, so far only one project, Monroe City, is beyond the pre-planning stage.

A few barriers have come into focus on the private industry level. One of these has been alluded to earlier: the question of unitization. At the state level it is mostly

TABLE 16

Major Geothermal Developers In Utah

AMAX Exploration, Inc.
Chevron Resources Company
Geothermal Kinetics, Inc.
Geothermal Power Corporation
Hunt Energy Corporation
Nelson B. Hunt
Caroline Hunt Trust Estate
Getty Oil Company
Hydro-Tech Company
McCulloch Oil Company
O'Brien Resources Company
Phillips Petroleum Company
Republic Geothermal, Inc.
Thermal Power Company
Union Oil Company
Utah Power and Light

Utilities

Utah Power and Light Company
Bountiful Light and Power Company
Escalante Valley Electric

Potential Direct Use Developers

Monroe City
McCulloch Oil Company
Utah Forester's Office
Escalante Valley Electric

concerned with the rights to the resource; at the industry level, however, it takes on aspects related to a whole spectrum of inter-company negotiations, of which unitization is only a single manifestation. It is obvious that if companies would share data and technical know-how, geothermal development would proceed significantly more rapidly. But, private companies operate on a basis of complex motives, of which profit is certainly the most influential but not the only one. It should be recognized that the right of self-determination, though limited, is fundamental to the free enterprise system.

An impediment which is beginning to manifest itself but which has not yet fully impacted development is the availability of drill rigs. A number of developers have commented on the fact that geothermal drill rigs were difficult to contract, in a few cases because of added restrictions imposed by the DOE Case Study Program. Although there is at present no real scarcity of drill rigs, competition for the rigs with oil and gas exploration is keen. Geothermal exploration in Utah is at a disadvantage because oil rigs must be modified to accommodate blow-out prevention equipment. The rigs usually must be brought long distances to the geothermal fields in Utah (usually from New Mexico, Nevada, or possibly from Colorado or Northeastern Utah), and rig contractors prefer continuous contracts as opposed to single wells. If exploration continues at its present rate, enough rigs can probably be brought into the geothermal fields so that no shortage will occur. However, if exploration and development is to accelerate, particularly at rates required to meet energy goals,

drill rig unavailability may become more acute.

It has also been pointed out that if development throughout the region is to progress at hoped-for rates, a scarcity of drill rigs may manifest itself on a regional basis (Kingsolver, 1978).

Another problem at the industry level which must be faced is utility commitment to geothermal development. Utilities are by nature conservative about new energy sources. A number of developers have noted that when the utility is skeptical, it tends to make the developers more cautious because of uncertainty about the market.

This problem is particularly applicable to Utah. A few developers have indicated that they felt that the major utility in Utah, Utah Power and Light, may be overly conservative in their approach to geothermal energy. UP&L undertook exploratory activities several years ago which were very disappointing with respect to electrical production. At that time, UP&L withdrew from exploration, and has apparently been somewhat skeptical of potential electrical projects. They have, however, indicated that they would be willing to buy power from geothermal developments if it is economical; in the meantime, they require substantial evidence of a resource before committing themselves. They have also pointed out a need for more expertise in reservoir engineering to justify optimistic investments (Finlayson, 1978).

Because of the general reluctance by utilities to take risks with regard to geothermal reservoirs, and because the

federal loan guarantee program cannot be used by large companies, it appears that in many developments the power plant will be built by a smaller third company which would be brought in for just that purpose. This is the case at the Roosevelt Hot Springs prospect, where Phillips Petroleum will supply the steam; Rogers International will design, construct, and own the plant; and Utah Power and Light will buy the electricity. Under these arrangements the utility will have the option of purchasing the power plant after several years when the reservoir is fairly well proven.

Department Of Energy Involvement

As discussed previously, the Department of Energy, Division of Geothermal Energy (DOE/DGE) has responsibility for encouraging geothermal development in addition to its duties in the leasing/permitting process. As advocate, the DOE/DGE has set up a number of programs to assist the industry in bringing development to fruition.

In the initial phases of the DOE programs, assistance primarily took the form of research and development projects. The goal was to provide the basic technology needed to locate, recover, and utilize the resource. During the last few years the approach of the DOE has changed. The emphasis has shifted from technical research to a mission-oriented program in which the goals are the acceleration of commercial geothermal utilization.

In Utah, the four DOE direct assistance programs which have been most significant are the Industry Coupled Case Study Program, the State Cooperative Resource Assessment Program, the Direct Applications Field Projects Cost Share Program, and the Loan Guarantee Progam. In addition to these programs, the DOE has contracted with the University of Utah/University of Utah Research Institute, which will have lead responsibility for the planning and coordination of regional resource definition activities such as the State Cooperative Program. The DOE also indirectly funds the Operations/Research studies in the various states.

Industry Coupled Program

The Industry Coupled Case Study program has been mentioned earlier in connection with drilling in Utah. The program is designed to provide direct assistance to industry in return for data which then becomes public. Qualifying projects may include primarily deep exploratory well drilling, temperature gradient surveys, or one of a variety of geophysical/geological surveys. In Utah, some wells have been partially funded retroactively.

The guiding philosophy of the program, in addition to providing direct assistance and impetus to geothermal exploration has been to conduct a fairly intensive exploration program in a specific prospect. The program would thus result in a substantial amount of information covering a specific area. The advantage of this approach is, of course, that the geothermal potential of the area studied will be much better understood; the disadvantage is that the search for new potential areas takes a lower priority. There is apparently provision for funding of exploration in new prospects, but because funding is planned years in advance, there might be delay in providing assistance for new areas.

The case study program in Utah has been effective in accelerating exploration. Three new wells have been drilled with assistance from the program--the Getty well at Roosevelt and two wells by Union at Cove Fort/Sulphurdale. Without doubt these wells were drilled earlier than they would have been if no assistance had been available. In addition, data

from four wells was purchased retroactively--the three Thermal Power wells at the Roosevelt prospect and the first Union well (Forminco #1) at Cove Fort/Sulphurdale.

It may not be wise to judge the total success of the case study program until the third Union well is completed. However, the program has undoubtedly assisted the industry in the expensive and risky exploratory phases.

State Cooperative Program

The purpose of the state cooperative program is to compile data on moderate and low temperature resources, publish maps and reports detailing the resources, and to perform some on-site exploratory work, including drilling, at the highest priority sites. The program is visualized as a forerunner to a direct use industry coupled program, which is foreseen for about 1982.

In Utah, the state cooperative program has resulted in temperature gradient surveys of the Crystal Hot Springs prospect in South Salt Lake Valley, and the Midway prospect in the Heber Valley. At Crystal Hot Springs, the survey has resulted in several plans for direct use of the resource, although some of the plans are very unclear at this stage. The program also includes plans for surveys of the Beck's/Wasatch Hot Springs prospect, Utah Hot Springs, and other prospects along the Wasatch Front.

Direct Applications Field Projects

The field projects program provides cost share funds for

select, visible projects which demonstrate the feasibility of direct use applications. The projects are funded through Program Opportunity Notices (PON's).

Monroe City, a community along the Sevier River in Central Utah, applied for and was granted a PON for utilization of the geothermal resources at Monroe Hot Springs for space heating in the community. The total project is estimated to cost $1,589,029; the DOE will provide $924,029. The project will provide heat for the South Sevier School District High School, a city hall and fire station, a church building, a number of private homes, and several commercial ventures, i.e., motels, greenhouses, and apartments. The system will be expanded as it becomes economical and feasible. Although the PON has been granted, negotiations have not yet been finalized. The project definitely would not have been undertaken if the DOE funds had not been available.

Applications for the second PON were due in the middle of July, 1978. No specific plans are available at this time, but proposed developments may include Crystal Hot Springs, Beck's Hot Springs, and other prospects in Utah.

Loan Guarantee Program

The federal loan guaranty program was designed to provide some assurance to developers in the face of uncertain reservoir capacities and life spans. In effect, it is a form of reservoir insurance.

The two electrical developments in Utah which are in the firm planning stage (the Phillips/Rogers International

project and the Thermal Power/AMAX/O'Brien/VTN project, both at the Roosevelt prospect) have both made applications for the loan guarantee. Some of the other developers which were contacted by the Utah O/R team stated that the loan guarantee would be useful to them, but a significant number stated that they would not be able to use it.

There appears a double-edged sword built into the loan guarantee program. On the one hand, for a company which is quite large, as was the case with most of the developers mentioned above, the loan guarantee is useless because a large company cannot afford to default on a loan. Major utilities also cannot default. One solution to this problem is to bring in a smaller company to build and own the power plant. (Rogers International basically fulfills this function for the Phillips Petroleum/UP&L development.) However, the other side of the problem is that the loan applicant must come up with 25% of the total cost in order to qualify for the loan. For many small companies, this is very difficult.

There are several possible remedies for this situation. The simplest would probably be to allow the 25% to be applied to the total project. It would then include the wells and other work which had been completed earlier, and would allow the larger developers and the utilities to assist in the initial capital outlay (Berge,1978).

Another possible solution would be to use reservoir insurance. This has been suggested by several developers and utilities as being preferable to the loan guarantee (Finlayson,

1978; Public comment at DOE Regional Planning Meeting, June 28, 1978). Undoubtedly, a major revamping of the program would give rise to further problems yet unforeseen. These suggestions have almost certainly already come to the attention of the loan guarantee administrators.

The loan guarantee program was designed primarily for electrical projects or large direct-use projects. There is, however, a real need for loans or loan guarantees for small developers, usually direct users, who are faced with comparatively large initial costs just as the larger developers are. It would appear that some sort of simple, obtainable loan system needs to be initiated for these small users. The very minimum changes would involve simplification of the application procedures for the existing loan guarantee; other programs designed specifically with small developers in mind would be much more effective.

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SUPPLEMENTARY REFERENCES

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P. A. Smith, Chevron Resources Company

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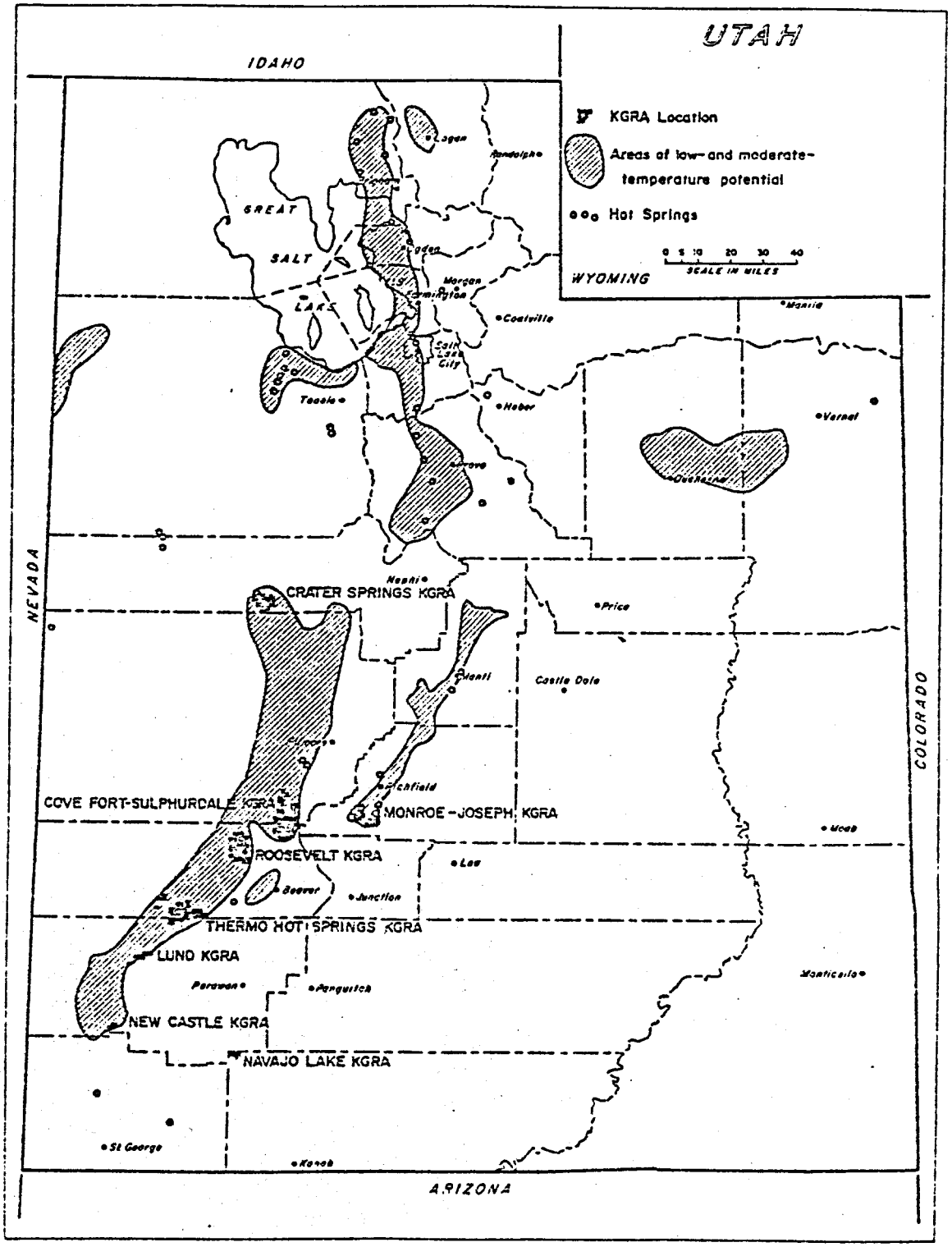
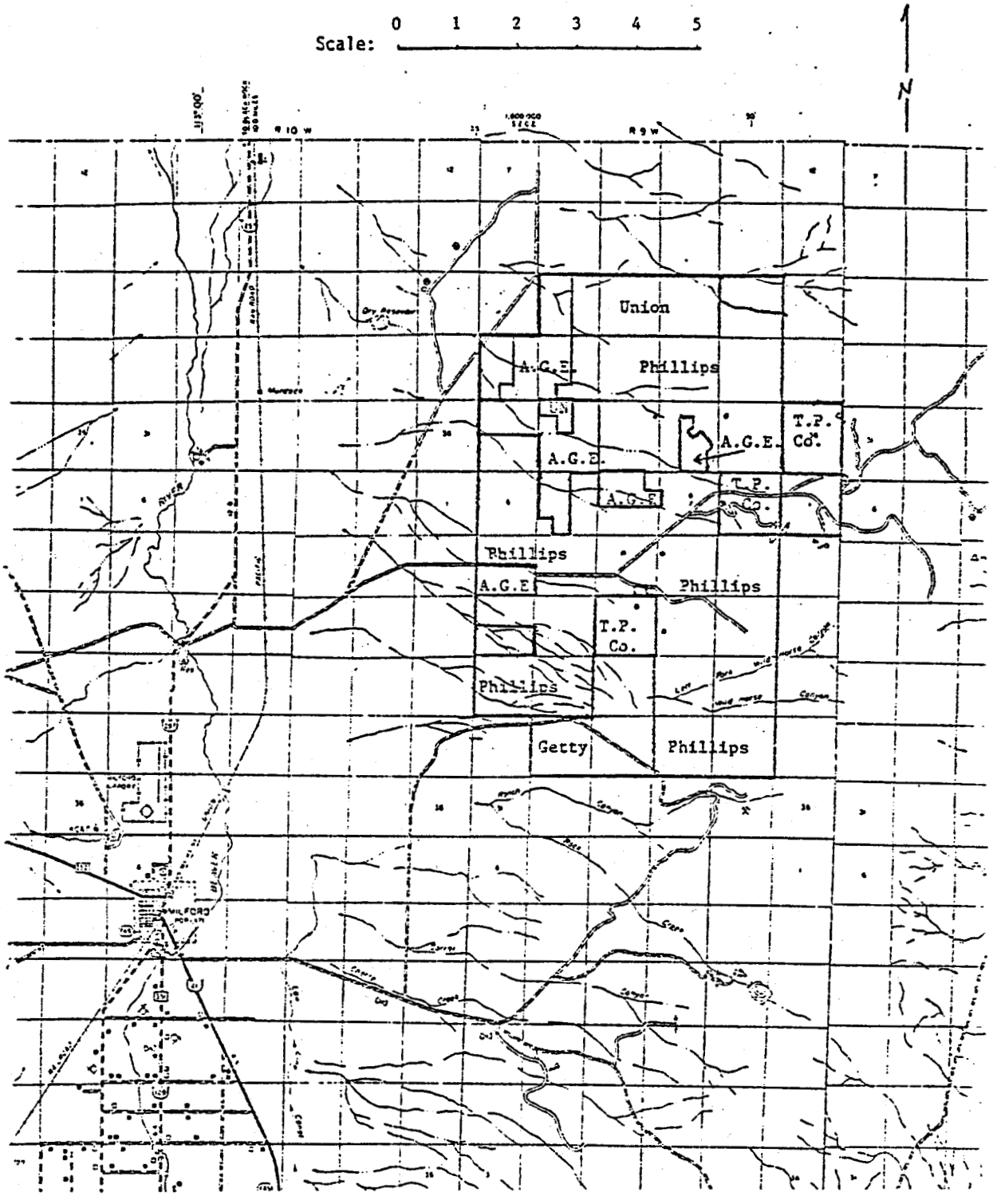
APPENDICES

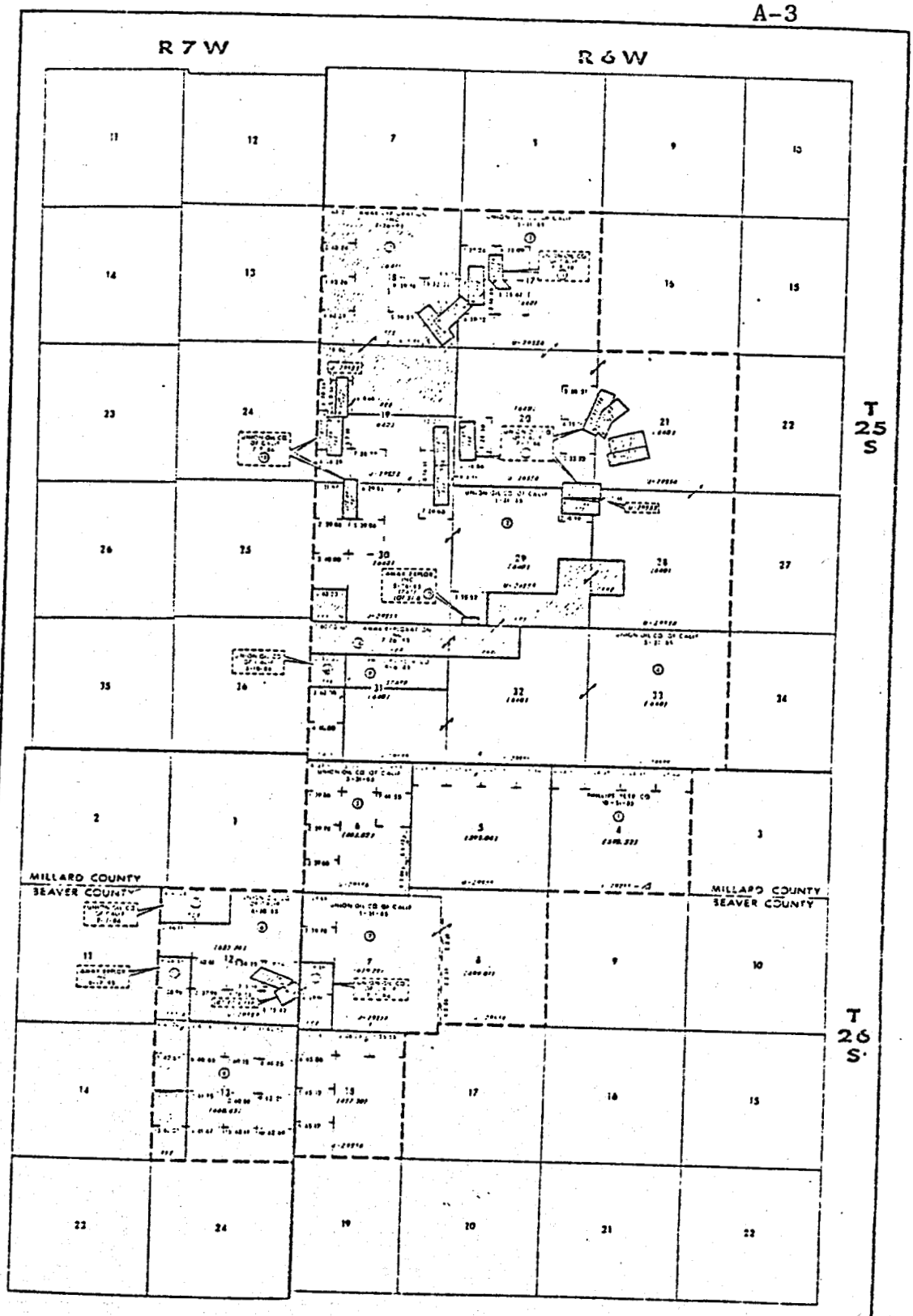
APPENDIX A


UTAH
IDAHO
WYOMING
NEVADA
COLORADO
ARIZONA
KGRA Location
Areas of low- and moderate-temperature potential
Hot Springs
SCALE IN MILES
GREAT
SALT
LAKE
CRATER SPRINGS KGRA
COVE FORT-SULPHURDALE KGRA
MONROE-JOSEPH KGRA
ROOSEVELT KGRA
THERMO HOT SPRINGS KGRA
LUND KGRA
NEW CASTLE KGRA
NAVAJO LAKE KGRA
Logan
Randolph
Morgan
Coalville
Salt Lake City
Tooele
Heber
Vernal
Manila
Nephi
Price
Castle Dale
Richfield
Beaver
Junction
Lee
Moab
Monticello
Panguitch
Parowan
St George
Kanab

Milford Area and Roosevelt Unit

Scale: 0 1 2 3 4 5



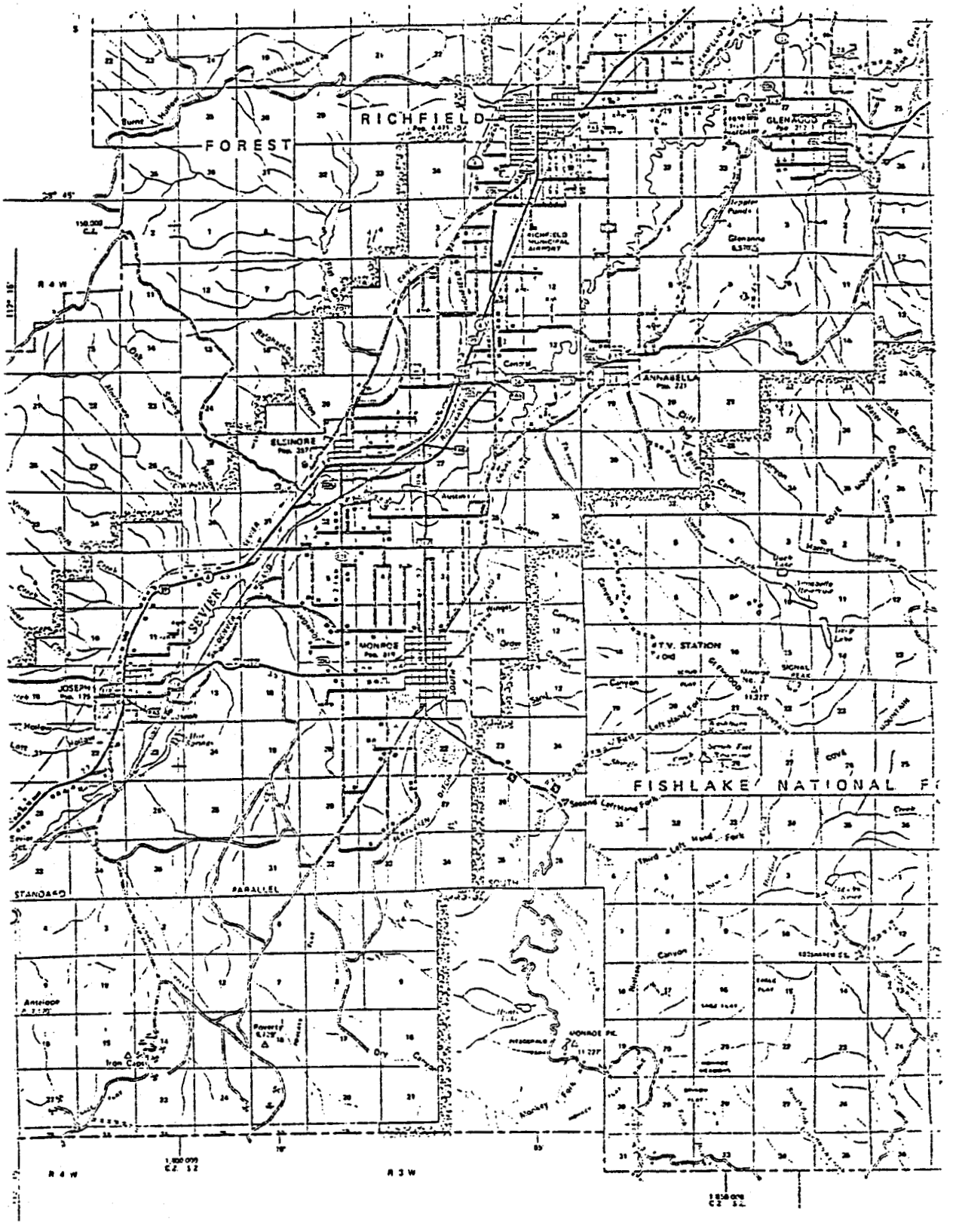


① TRACT NUMBER AS LISTED ON EXHIBIT "B"

UNIT OUTLINE

	acres	Percentage
FEDERAL LANDS	9 208.35	79.21%
STATE LANDS	204.68	1.76%
FEE LANDS	2 207.31	19.03%
TOTALS	11,620.34	100.00%

COVE FORT - SULPHURDALE UNIT AREA
MILLARD AND BEAVER COUNTIES, UTAH


RICHFIELD
FOREST
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FISHLAKE NATIONAL F
R 4 W
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ELSINORE
ANNABELLA
MONROE
JOSEPH
STANDARD
PARALLEL
SOUTH
R.T.V. STATION

APPENDIX B

Figure 1

Aggregated Scenario--Electrical Production from Geothermal Resources in Utah

	tot. MWe	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
Roosevelt Prospect	400			50		50		50		50		100		100								
Cove Fort Sulphurdale	200					50		50		50		50										
West Cove Fort	200						50		50		50		50									
North Cove Fort	200						50		50		50		50									
Thermo	100							50		50												
Other Areas (Sevier Lake, Black Rock Desert, Delta Area	200								50		50		50	50								
TOTAL FOR YEAR				50		100	100	150	150	150	150	150	150	150								
CUMULATIVE TOTAL				50		150	250	400	550	700	850	1000	1150	1300								

Figure 1 (Continued)

ASSUMPTIONS USED IN SCENARIOS

April 1978

Roosevelt Hot Springs Prospect

1. The reservoir capacity at the Roosevelt Prospect was assumed to be 400 MWe. This figure is averaged between Phillips (1) and UP&L (2) planning estimates of 300 MWe, and Dr. Stanley Ward's estimate of 500 MWe (3). The heat flow data compiled by Dr. David Chapman also indicates about 300-500 MWe. In this respect 400 MWe is considered an optimistic and fairly realistic estimate.

2. According to Phillips and UP&L (1&2), the plants are planned to come on-line in 55 MWe units two years apart if feasible. The following assumptions were based on this information:

   A. The plants were generally assumed to come on-line two years apart.
   B. The later plants were assumed to be 100 MWe Plants. This presumes:
      (1) Adequate reservoir capacity.
      (2) Development by a single operator (unitization).
      It is possible that later plants might be 55 MWe plants on-line each year.

Cove Fort

1. Several factors will tend to retard development at Cove Fort (Sulphurdale).

   A. Drilling has been very difficult. It has taken a long time and considerable problems were encountered from a geological standpoint.
   B. Because of these problems with drilling, the wells drilled by Union have been very expensive.
   C. The presence of a viable reservoir has not yet been satisfactorily verified.

2. In spite of these setbacks, several ventures are proceeding (4). For purposes of the long-range scenario, the following separate ventures were assumed.

   A. Sulphurdale--Union could have two areas here, one north of the freeway, one south. Because Union still appears to be progressing, the first plant was assumed to come on-line in 1984. The sites are left unspecified. This is an optimistic forecast, particularly in light of the difficulties mentioned above.

Figure 1 (Continued)

B. North Cove Fort (Dog Valley)--Hunt Energy Corp. is currently drilling on private lands several miles north of the Sulphurdale area. An optimistic forecast would put them on-line about 1985 or, at best, 1984. Of course, the controlling factor will be the discovery of a reservoir.

C. West Cove Fort Area--Several groups are conducting intensive exploratory activities in this area, although no deep wells have been drilled. Developers in this area are AMAX, Hunt, Chevron, Phillips, and others. An optimistic estimate could place at least one of these prospects on-line in 1985 (4). Because several developers are involved, the plants could come on-line in bunches; the assumption for the scenario was usually a plant each year.

3. Reservoir Quantities: Based roughly on various estimates of reservoir capacity, the following quantities were assumed:

   Sulphurdale 200 MWe.
   North Cove Fort 200 MWe.
   West Cove Fort 200 MWe.

   These assumptions appear to be optimistic but reasonable. Sulphurdale, North Cove Fort, and West Cove Fort were assumed to have 200 MWe capacity each. Again, these capacities are not scientific reservoir estimates but are useful for purposes of estimating development patterns.

4. Federal Programs and other incentives/assistance: It was assumed that optimistic estimates would be partially justified by the development of federal initiatives to accelerate and assist development in Cove Fort areas. Such programs were left unspecified but will probably include case study programs, technology transfer, and the reduction of institutional restrictions.

   Note: Cascading and multiple use systems will very likely be developed for some of these areas, most particularly in the Sulphurdale area where exhaust from the power plant may be used in sulphur mining or other industrial operations (4).

Thermo Prospect

1. Reservoir capacity was assumed to be 100 MWe. This is a moderately optimistic assumption. The rationale for this estimate was that the area involved might be larger than the 1.5 km^2 estimated by USGS Circular 726, although at this time there is little evidence to support this hypothesis.

Figure 1 (Continued)

2. Earlier scenarios estimated drilling to begin at Thermo in 1980 (6). Republic Geothermal drilled a deep well in late 1977. This would seem to indicate that development at Thermo could be advanced by as much as two years. Also, federal programs could make an earlier production date feasible for Thermo as well as for some of the Cove Fort areas. On the other hand, preliminary information from the Republic Well at Thermo does not seem to justify boundless optimism; hence, the first plant was estimated to produce power on-line about 1986, with another 50 MWe plant following two years later.

Figure 1 (Continued)

References

1. Phillips Petroleum Co., Verbal and written communications, February and March, 1978.

2. Dr. Val Finlayson, Director of Research and Development, Utah Power and Light Company, Salt Lake City, Utah. Personal Communication, March 28, 1978.

3. Dr. Stanley H. Ward, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah. Personal Communication, March 28, 1978.

4. Kenneth Bull, U.S. Geological Survey, District Geothermal Supervisor, Salt Lake City, Utah. Personal Communication, April 4, 1978.

5. State and Federal Geothermal Leases, compiled by the Utah State Team, February, 1978.

6. MITRE Corporation, METREK Division, "Site Specific Analysis of Geothermal Development--Data Files of Prospective Sites." October, 1977.

BASIC ASSUMPTIONS FOR SCENARIOS

Electrical Production from Geothermal Resources in Utah

1. Reservoir: For purposes of the planning scenarios, it was assumed that geothermal reservoirs would be discovered early at each prospect. (So far, the Roosevelt Hot Springs prospect is the only one where a geothermal reservoir has been verified). It was also assumed the reservoirs at each prospect will be commercial, with both adequate heat and adequate volume for electrical production. It was assumed that the reservoir will not be so deep or difficult to drill that exploration and production drilling is not economical.

   The following reservoir capacities were assumed, although there is as yet little evidence for these quantities:

Roosevelt Hot Springs:	400 MWe
Cove Fort/Sulphurdale:	200 MWe
West Cove Fort:	200 MWe
North Cove Fort:	200 MWe
Thermo:	100 MWe
Other Potential Areas:	200 MWe

   Most of these assumed capacities are probably high, particularly for the Cove Fort areas. These data will be adjusted as soon as more information becomes available.

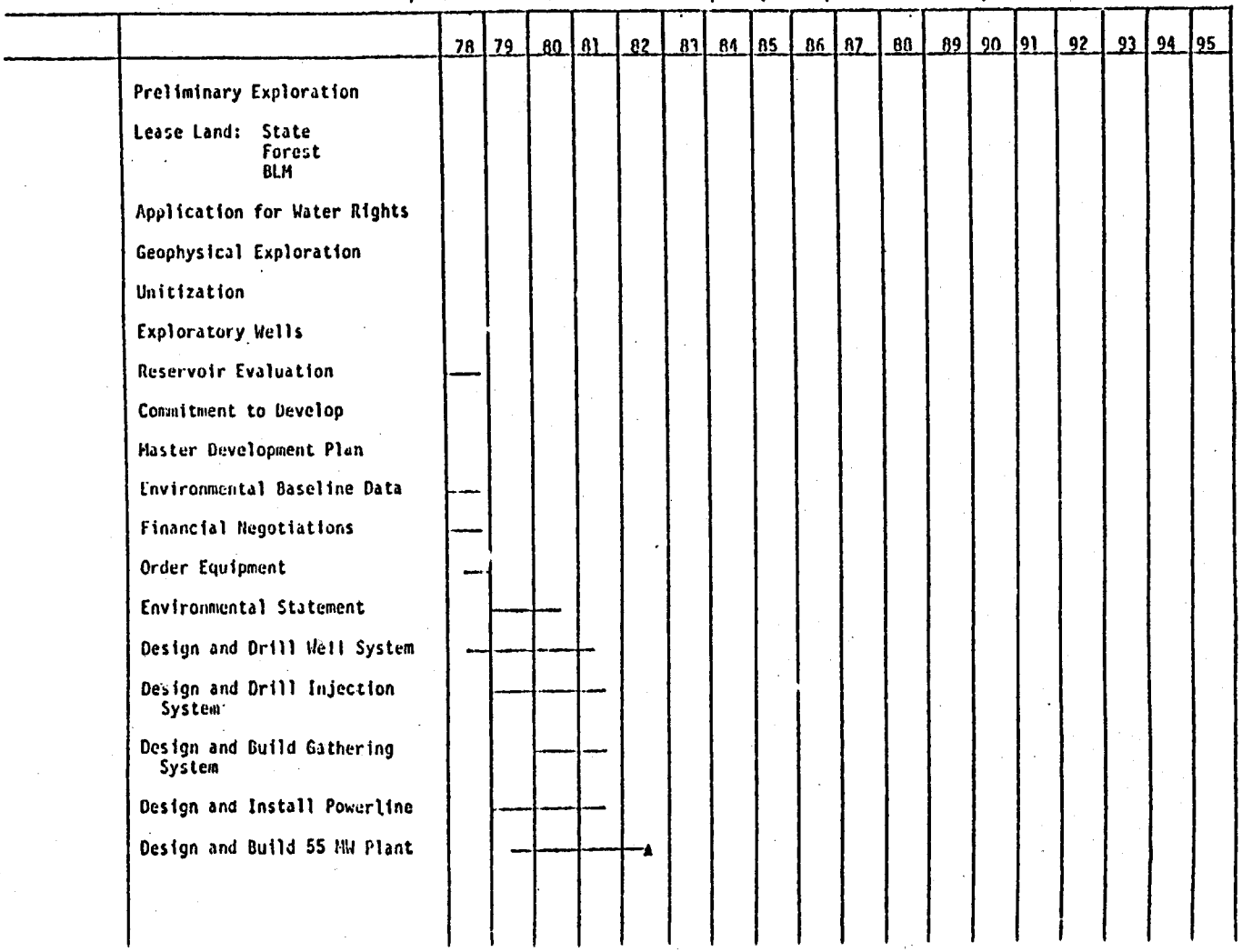
2. Economics: It was assumed for each prospect that development will be economically advantageous to the developers. This includes the assumptions that the reservoir will be commercial. Also, it was assumed that capital will be available to finance development. The power was assumed to be marketable, i.e., that the utilities (primarily Utah Power and Light) will agree to buy and/or wheel the power. It was also assumed that no further economical burdens will be placed on the developer by delays, environmental problems, etc. In addition, it was assumed that some federal assisance will be available to reduce the pressures of the other assumptions; not necessarily to fund the operations, but to provide some financial assistance through cost-share programs, loan or reservoir guarantees, tax incentives, reduction of institutional delays, etc.

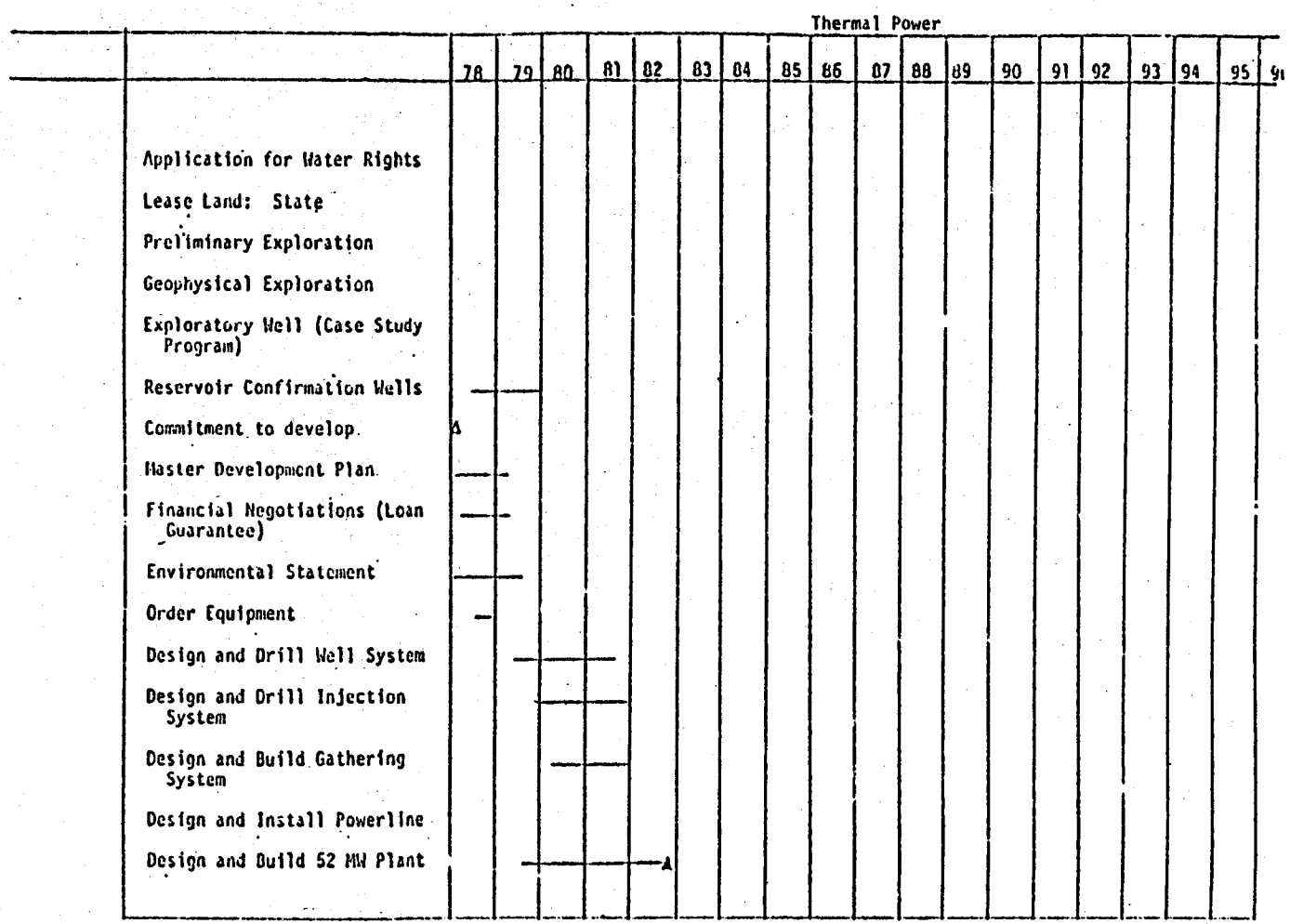
3. Institutional: It was assumed for each prospect that no unforeseen delays or problems due to institutional factors will occur. This includes the assumption that permitting will be prompt and will not be more restrictive than past permitting.

Continued

It was also assumed that new regulations which might restrict or retard development will not be added. Lawsuits and other legal actions were assumed not to accur, whether concerned with the environment, water rights, land disputes, mineral rights, or other potential issues. It was assumed that no delays will be imposed by State or local governments over such issues as water rights, zoning ordinances, building permits, discharge permits, etc. It was assumed that major environmental impact statements would not be required for any phase of development at any of the prospects.

Possible Development Forecast: Roosevelt Prospect (Phillips Petroleum Co.)




Thermal Power
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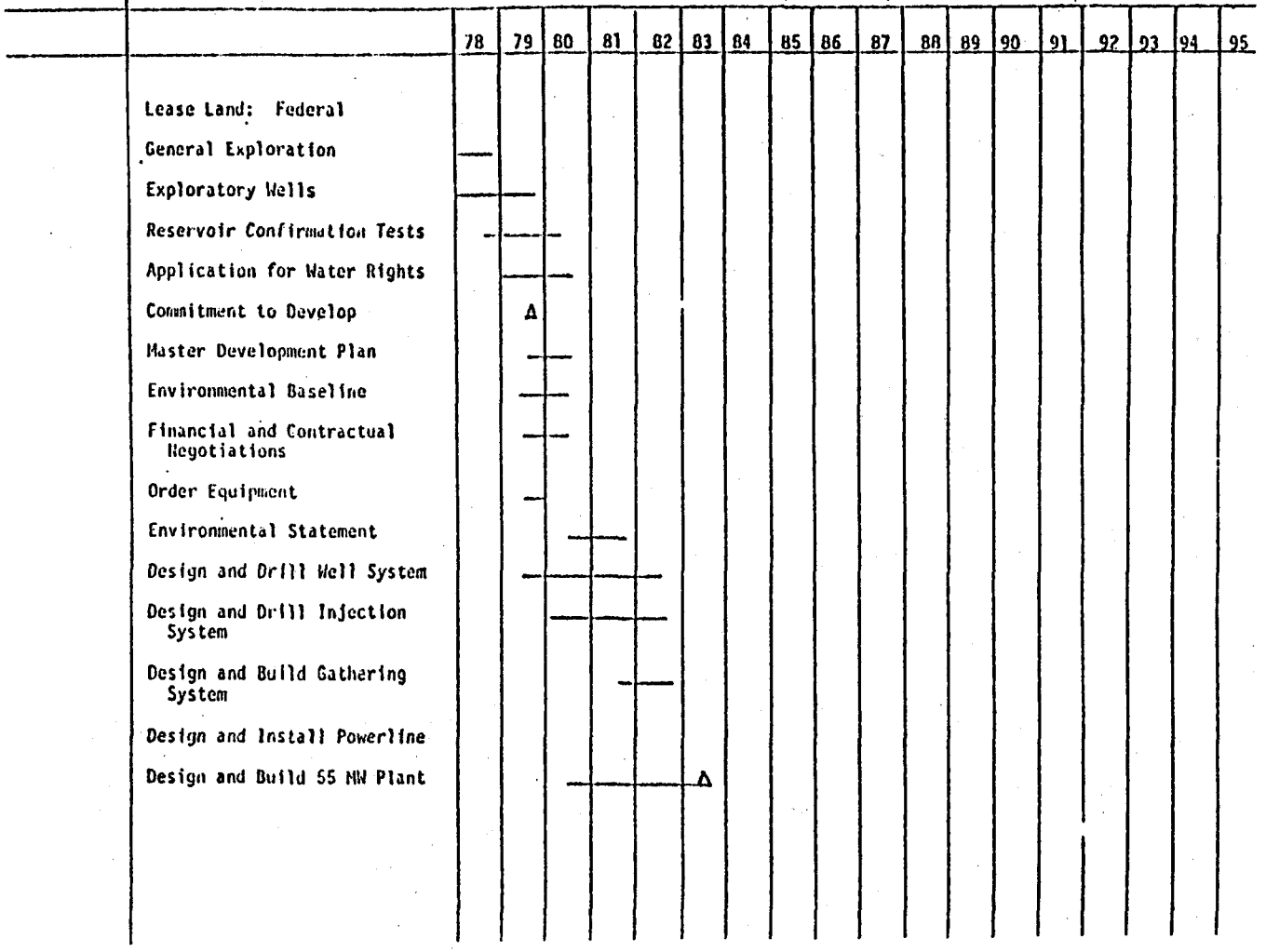
Application for Water Rights
Lease Land: State
Preliminary Exploration
Geophysical Exploration
Exploratory Well (Case Study Program)
Reservoir Confirmation Wells
Commitment to develop
Master Development Plan
Financial Negotiations (Loan Guarantee)
Environmental Statement
Order Equipment
Design and Drill Well System
Design and Drill Injection System
Design and Build Gathering System
Design and Install Powerline
Design and Build 52 MW Plant

Possible Development Forecast: Roosevelt Prospect (Getty Oil Co.)



Summary: Getty

The federal leases held by Getty Oil Company are located near the south end of the Roosevelt prospect. The leased area is not large (three sections) but the dome fault, which apparently provides a system of conduits for the geothermal fluids, runs through the lease.

Extensive exploration and drilling has been done throughout the prospect by various developers. Getty recently finished drilling a deep exploratory well with federal assistance under the industry coupled case study program. The data from this well has not yet been made public.

The Roosevelt Prospect has been partially unitized. At this time only Phillips Petroleum and Union Oil Co. have joined the unit. Getty Oil Co. and the Thermal Power/ AMAX/O'Brien/VTN Consortium have not yet accepted the unit agreement. Whether or not Getty and the Consortium will join the unit and when they might do that is a matter that defies speculation at this time. The Proposed Geothermal Rules and Regulations for Utah, as issued by the Division of Water Rights, state that the State Engineer has the authority to enforce unitization, but there are legal questions which still need to be resolved. In any case, unitization by the State Engineer would be a possibility only after extensive, careful investigation and consideration.

For the purposes of the individual scenarios, Getty was considered a possibility for a plant by about 1983. This would assume that Getty did not join the unit but developed the field and built the power plant themselves. It was also assumed that only one power plant would be viable on the Getty leases. There is at this time no way to verify or negate either of these assumptions, but the whole scenario picture will be updated as soon as new information becomes available. For purposes of an aggregated scenario for the whole prospect, the Phillips forecasts were followed, as if Getty and the Consortium did join the Unit. These assumptions merely represent (hopefully) a fairly reasonable compromise between two very divergent possibilities.

If Getty does develop a power plant it probably will not use the loan Guarantee program inasmuch as it is a major developer. Development will depend very much on the economic advantage of the situation. On the other hand,

Continued

13. It was assumed that the design and construction of the plant would take about three years, and that the plant would be completed about 1983.

Getty--Specific Assumptions

1. It was assumed that general geophysical exploration will continue, particularly to locate further exploratory wells. Exploratory wells were assumed to be drilled for another one and a half to two years. This would require a good discovery well and that the confirming wells are also sucessful.

2. Reservoir confirmation tests were assumed to begin as the exploratory wells are tested and to continue for six months to one year after exploratory drilling has been completed.

3. Water rights were assumed to impose no significant delay in development, even though the application probably will not be acted upon until reservoir information has been gathered.

4. The commitment to develop was assumed to follow confirmation of the discovery. The reservoir has already been confirmed although its characteristics have not been completely investigated. This will probably make it possible for Getty's commitment to be fairly secure relatively early.

5. It was assumed that Getty would gather part of the required baseline data and acquire part of it from Phillips.

6. Financial and contractual negotiations were assumed to begin shortly before the commitment to develop was made, and were assumed to continue about a year.

7. It was assumed that the generating equipment would be ordered shortly after the commitment to develop was made.

8. The environmental statement was assumed to begin after all baseline data had been collected, and to extend about a year. Again, Getty should be able to get some data from Phillips.

9. It was assumed that design and drilling of the production wells would begin about the time that the commitment to develop was made, and that it would extend two to three years.

10. The injection system was assumed to trail the production well system by a few months.

11. The gathering system was assumed to be completed a few months after the production and injection systems were completed and to have taken a little over a year for design and construction.

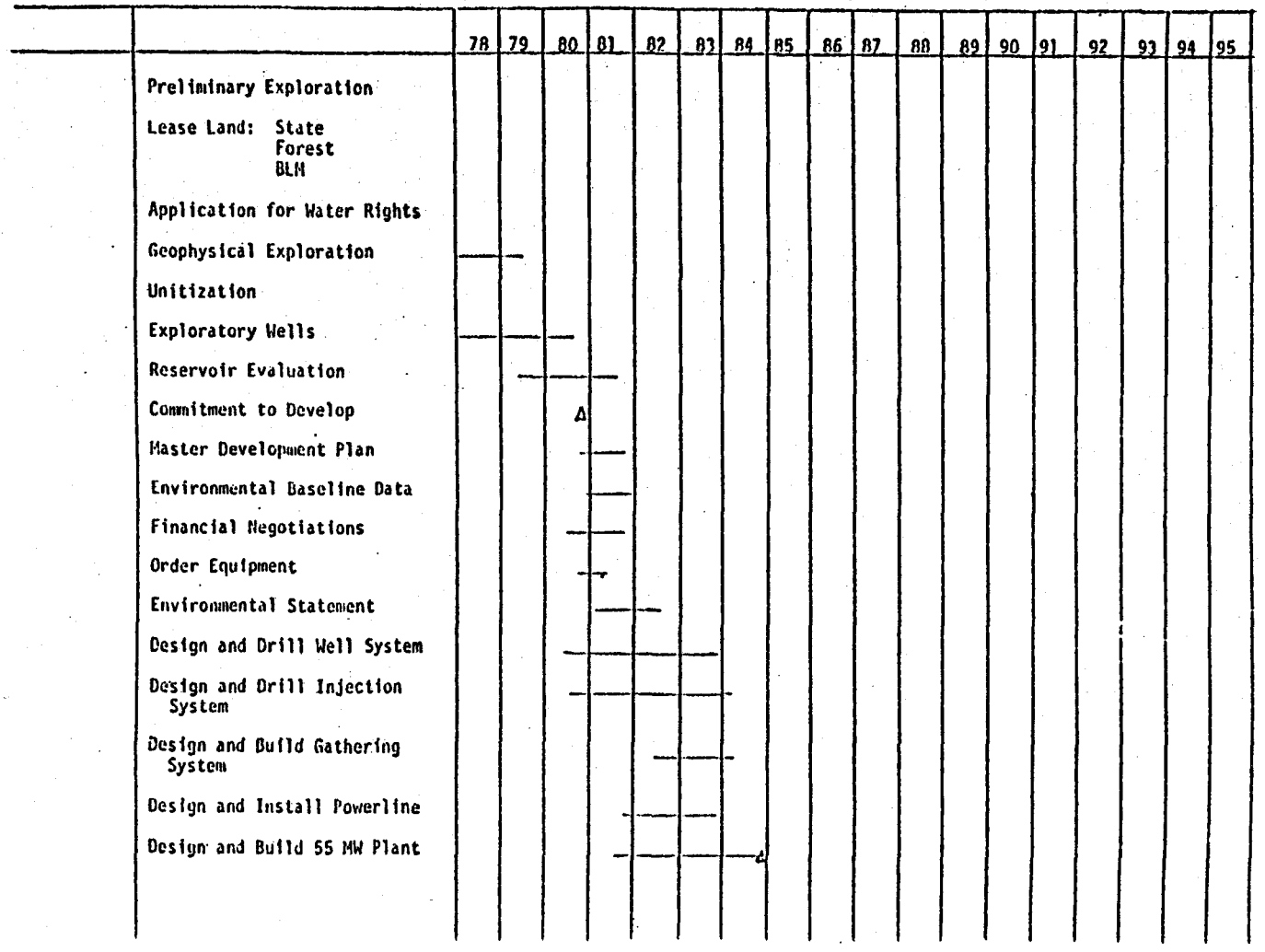
12. The power line will be constructed by Utah Power and Light, and the line built for the Phillips/Rogers plant will be used for subsequent plants.

Continued

Getty reported that their recent use of the case study program was a definite incentive to accelerate exploration.

No extraordinary drilling problems were encountered by Getty. Phillips plans to gather environmental data for their baseline study (contracted to Woodward/Clyde Consultants) and Getty would probably be able to negotiate for much of the information it needs to fulfill its own environmental requirements.

Possible Development Forecast: Cove Fort/Sulphurdale (Union Oil Co.)



Summary: Cove Fort/Sulphurdale Prospect (Union Oil Co.)

The vicinity of Sulphurdale near Cove Fort has been considered a major potential resource area in Utah. Although there are no surface springs, Mundorff (1970) reported active gas seeps and thermally altered areas. The Cove Fort/Sulphurdale prospect was estimated by USGS Circular 726 to contain about 274 MWe, and the MITRE Corp. cited an unidentified ERDA-DGE source which estimated 500-1500 MWe for the prospect.

In the summer of 1976, Union Oil Co. drilled an 1100 foot exploratory well on private leases. The well was plagued by drilling difficulties and eventually caved in.

The Cove Fort Unit was formed in January, 1977, by Union Oil Co., the unit operator, Phillips Petroleum Co., and AMAX Exploration, Inc.; W. H. Hunt joined January, 1978.

In late 1977, Union drilled a second deep exploratory well. Although the drilling went much deeper, it was once more very difficult. Final results from the well have not yet been made public. Union has recently begun drilling a third well at a site somewhat between the other two sites.

The difficult drilling at Cove Fort has made the wells thus far very expensive. All three of the wells at Cove Fort/Sulphurdale were partially funded through the DOE Industry-Coupled Case Study Program.

Specific Assumptions: Cove Fort/Sulphurdale (Union Oil Co.)

1. Most of the preliminary exploration, leasing of land (from the state of Utah, BLM, U.S. Forest Service, and private owners), and negotiations for unitization were assumed to be completed.

2. It was assumed that the appropriation of water through the Division of Water Rights will not cause delay, and that the Division will not act on the application until the reservoir had been fairly well established.

3. It was assumed that a discovery well will be drilled during 1978 which would trigger development. Each non-producing well which is drilled will set the whole scenario back in time. It was assumed that confirming wells will be drilled within a period of 1-1½ years following the initial discovery.

4. It was assumed that reservoir evaluation tests will begin after the reservoir has been confirmed and will continue as subsequent producing wells are brought in. In addition to major tests on the individual wells, the long-term reservoir test may last more than a year.

5. It was assumed that the commitment to develop will be made when several producing wells have been drilled and tested and the reservoir is fairly well confirmed, although reservoir tests will continue after the decision point. It was assumed that the tests results will convince the utilities of the viability of the project.

6. The master development plan was assumed to be initiated at about the time of the commitment to develop, and was assumed to take about a year to complete.

7. The gathering of one year's environmental baseline data was assumed to begin about the time that the commitment to develop is made. The whole process will probably last a year and several months because approval from the USGS is necessary; however, these preliminary processes will probably be initiated before the utility is convinced. Baseline data will be necessary only for the federal lands, but will probably be gathered for the whole area enclosed by the unit boundaries.

8. Financial negotiations were assumed to begin a short time before the actual commitment to develop is made. These negotiations will probably involve the unit operator and other unit members, the utility, the power producer (if a smaller go-between company is brought in as was the case at Roosevelt), and eventually the DOE if the loan guarantee is used. Financial negotiations were assumed to be completed after about a year.

Continued

9. It was assumed that it will be necessary to order some of the generating equipment three to four years before the facility is completed.

10. The environmental statement was assumed to begin as the baseline study ends and to continue for about 1½ years. U.S. Forest Service involvement could extend the time necessary to complete the environmental statement.

11. The design and drilling of the well system was assumed to take a little over three years to complete. This extended time was assumed in order to take into account difficult drilling conditions known to exist in the Cove Fort area. Although the scenario is meant to reflect a fairly "optimistic--realistic" situation, the geology in the Cove Fort Area is known to be difficult to drill.

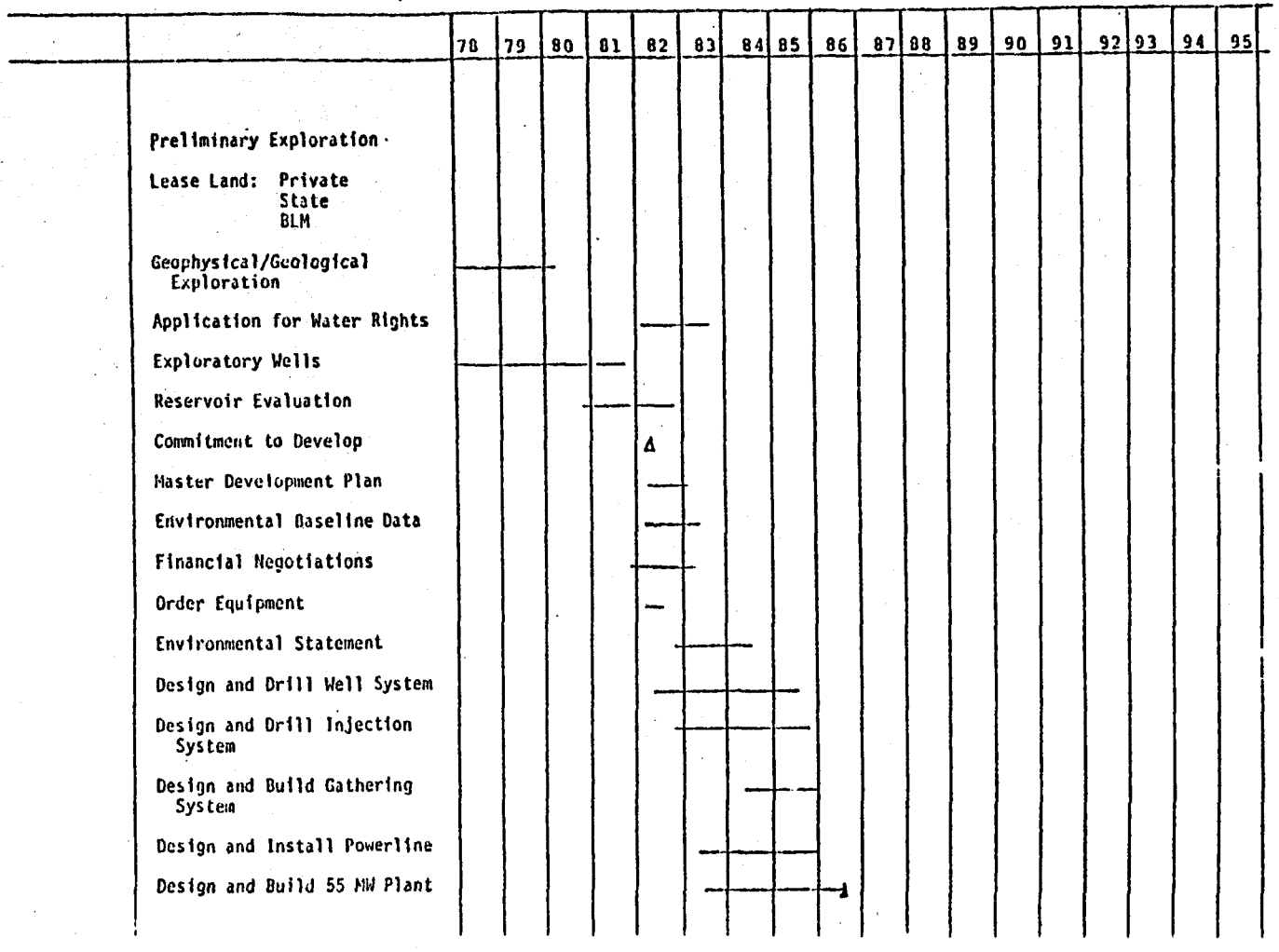
12. The design and construction of the injection system was assumed to begin a few months after the production well system and to continue until after the production well system has been completed.

13. The design and construction of the gathering system was assumed to last from 1½-2 years, and to be completed a few months after the injection system was completed.

14. Two power lines presently pass through the Cove Fort/Sulphurdale area, a 46 KV line and a 138 KV line. If the discovery at Cove Fort/Sulphurdale is not too large, these power lines might suffice. If discoveries are also made in the north Cove Fort and West Cove Fort areas, it may be necessary to construct power lines to connect these areas into the network.

15. The design and construction of the power plant was assumed to take about three years, and was assumed to be completed about 1984.

Possible Development Forecast: Thermo Prospect (Republic Geothermal, Inc.)



Summary: Republic Geothermal at Thermo, Utah

Republic has drilled one well in the Thermo area. The well has not yet been completely tested and is currently suspended.

Republic Geothermal is a smaller company than many of the major developers, and specializes in geothermal exploration and development. Republic is heavily involved with two power plants in the Imperial Valley in California, and at this time the Thermo prospect carries a somewhat lower priority.

The information from the well at Thermo has not yet been made public. Indications are that the well shows some promise. No extraordinary geological difficulties were encountered.

The prospect at Thermo is somewhat isolated. This causes more expense in moving drill rigs into the area and also means that a power line would have to be constructed to carry power to the network. Most of the prospect is in the flatlands of the Escalante Desert, which will possibly ease environmental constraints.

Specific Assumptions: Republic Geothermal at Thermo, Utah

1. It was assumed that some geophysical exploration will still be necessary to evaluate drilling prospects and locate the well sites. This activity will probably not be intense for a while, and will probably extend over a year or more until Republic is ready to resume intense exploration.

2. Water Rights are assumed to present a minimal problem although approval will probably not be granted until development is fairly well along.

3. The well which has been drilled has not yet been fully tested, and Republic has voiced no firm plans for further drilling. It was assumed that drilling will not take place immediately and that it will be somewhat spaced out over a period of several years. This phase of development could be altered to accelerate or retard over-all development.

4. Reservoir evaluation was assumed to begin as producing wells are drilled and to continue for about a year while producing wells are used to analyze the reservoir characteristics.

5. The commitment to develop was assumed to occur after a number of producing wells have been drilled and the reservoir has been evaluated, possibly about 1982.

6. The master development plan was assumed to extend about a year beyond the time the commitment to develop is made or about 1982.

7. The Environmental Baseline Data Program was assumed to begin as soon as development becomes likely, or would begin about the time that the commitment to develop is made.

8. Financial negotiations were assumed to begin several months before a commitment to develop was made, and to continue for about a year.

9. It was assumed that it would be necessary to order the generating equipment about four years before the plant was scheduled for completion. This was estimated to be done around mid-1982.

10. The environmental statement was assumed to overlap with the gathering of baseline data. It was assumed to continue about a year and a half. The vegetation and terrain is fairly homogenous, mostly flat desert with salt brush and greasewood.

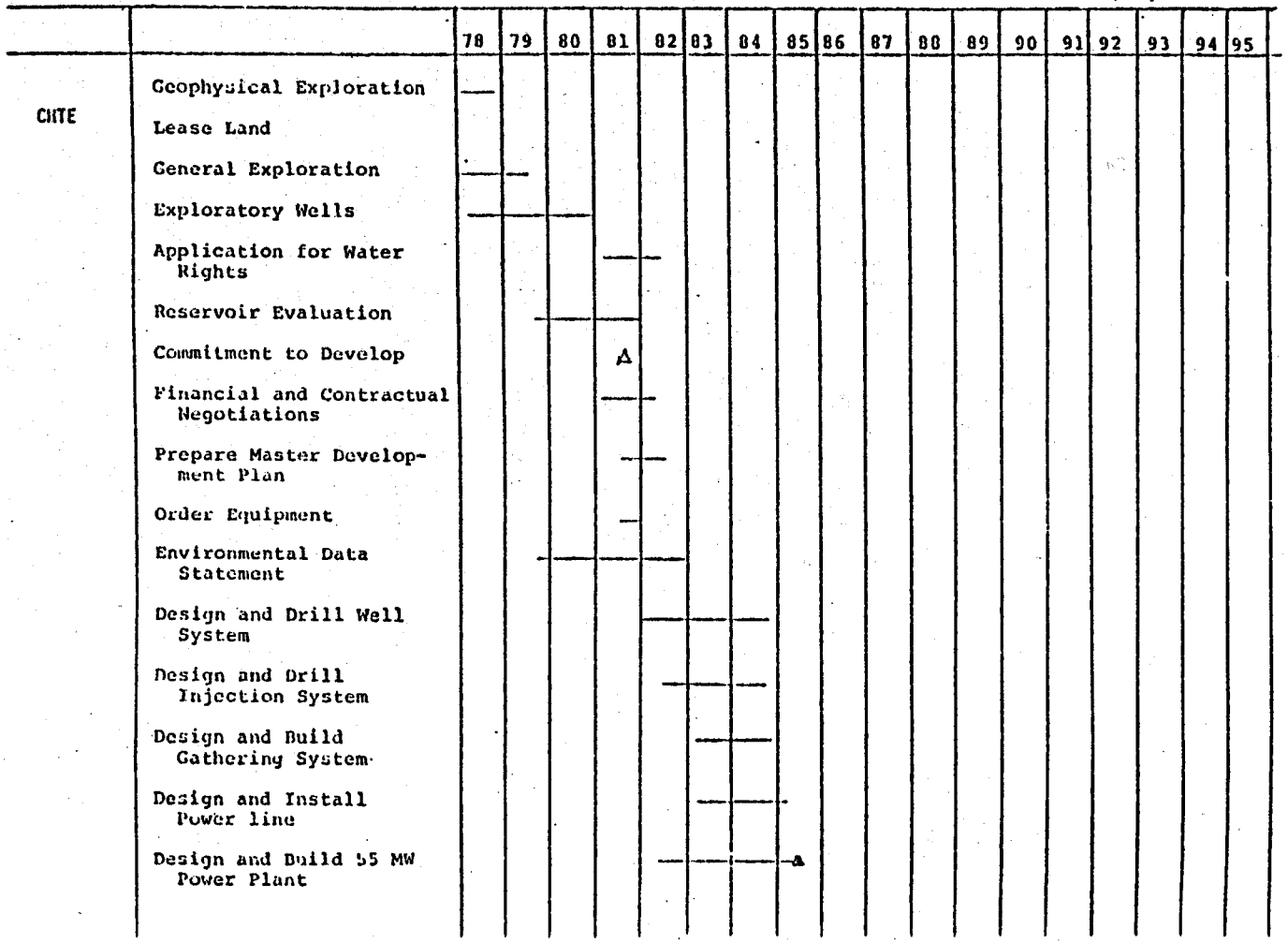
Continued

The area has also been covered as part of a ground-water flow study by the USGS. These factors would possibly simplify the environmental analysis of the area.

11. It was assumed that the design and drilling of the well system would take about two and a half to three years. The time frame would be somewhat flexible. The design and drilling of the injection system would probably begin shortly after the production system is begun, and the gathering system would last about a year and a half and would be completed near the same time as the injection system.

12. Republic already has experience in building power plants and is more likely to constuct their own plant than many developers would be. Construction would probably last two and a half to three years, and would possibly be completed about 1986.

Possible Development Forecast: North Cove Fort Prospect (Caroline Hunt Trust Estate)



Summary: Hunt Energy Corporation--North Cove Fort Prospect

The Caroline Hunt Trust Estate holds geothermal leases on fee lands in the Dog Valley/White Sage Flat area north of the Cove Fort Unit. Hunt has conducted geophysical and temperature gradient surveys of the area and is presently drilling a deep exploratory well.

The area of most interest to Hunt is a hilly juniper and sagebrush area south and west of Kanosh. The fee lands are bordered by National Forest lands to the east and by BLM lands several miles west. Depending on the results of the exploration, these federal lands may eventually be associated with the prospect.

It appears in general that dilling in the Cove Fort Area is not easy, but information from the Hunt well has not yet been made public. Hopefully, it will be possible to avoid some of these difficulties in later wells, but because the difficulties appear to be associated with the general geology of the region, it was assumed that they would be encountered in most drilling. At this point, the reservoir characteristics are still unknown, and any estimate of reservoir capacity must be considered more to be an assumption, rather than a forecast.

Hunt is a large, well established company, and like other major companies and utilities would have little use for a loan guarantee program; however, money available through a bottom-hole information program such as the case study program could be useful to them.

Hunt Energy Corporation--Specific Assumptions

1. It was assumed that most of the leasing for the area has already taken place, and that most but not all of the geophysical exploration has taken place.

2. It was assumed that, given a discovery at the first well, exploratory drilling would continue for about two and a half to three years. The general rule of thumb of about two years for exploratory drilling modified somewhat to take difficult drilling conditions into account.

3. Hunt has filed for water rights in this area. Although the water rights will probably not be acted upon until more is known about the reservoir, it is unlikely that the development will be held up by the appropriations process.

4. The reservoir evaluation was assumed to continue about two years, overlapping with the later stages of exploratory drilling. Assuming that the reservoir proved suitable, the evaluation would lead to a commitment to develop about three to four years after discovery, or about 1981.

5. Financial negotiations were assumed to begin shortly before the commitment to develop was made, and would probably continue about a year or so.

6. The master development plan would probably continue about a year following the commitment to develop.

7. Shortly after the decision to develop has been made, the generating equipment should be ordered, since there is now a three to four year interval for generating equipment.

8. The Hunt leases are on private leases but, because of the proximity to federal lands, Hunt will probably fulfill the federal requirements for environmental studies. This environmental statement would include the one year baseline study, which would probably begin after the discovery was confirmed. The major environmental report probably would not begin until the commitment to develop was fairly secure.

9. The design and drilling of the well system were estimated to take two to two and a half years, possibly longer because of difficult drilling conditions in the Cove Fort Area.

10. The design and construction of the injection system was assumed to begin a few months after the production well system was begun, and to continue until a short time after the production well system is completed. It is likely that the

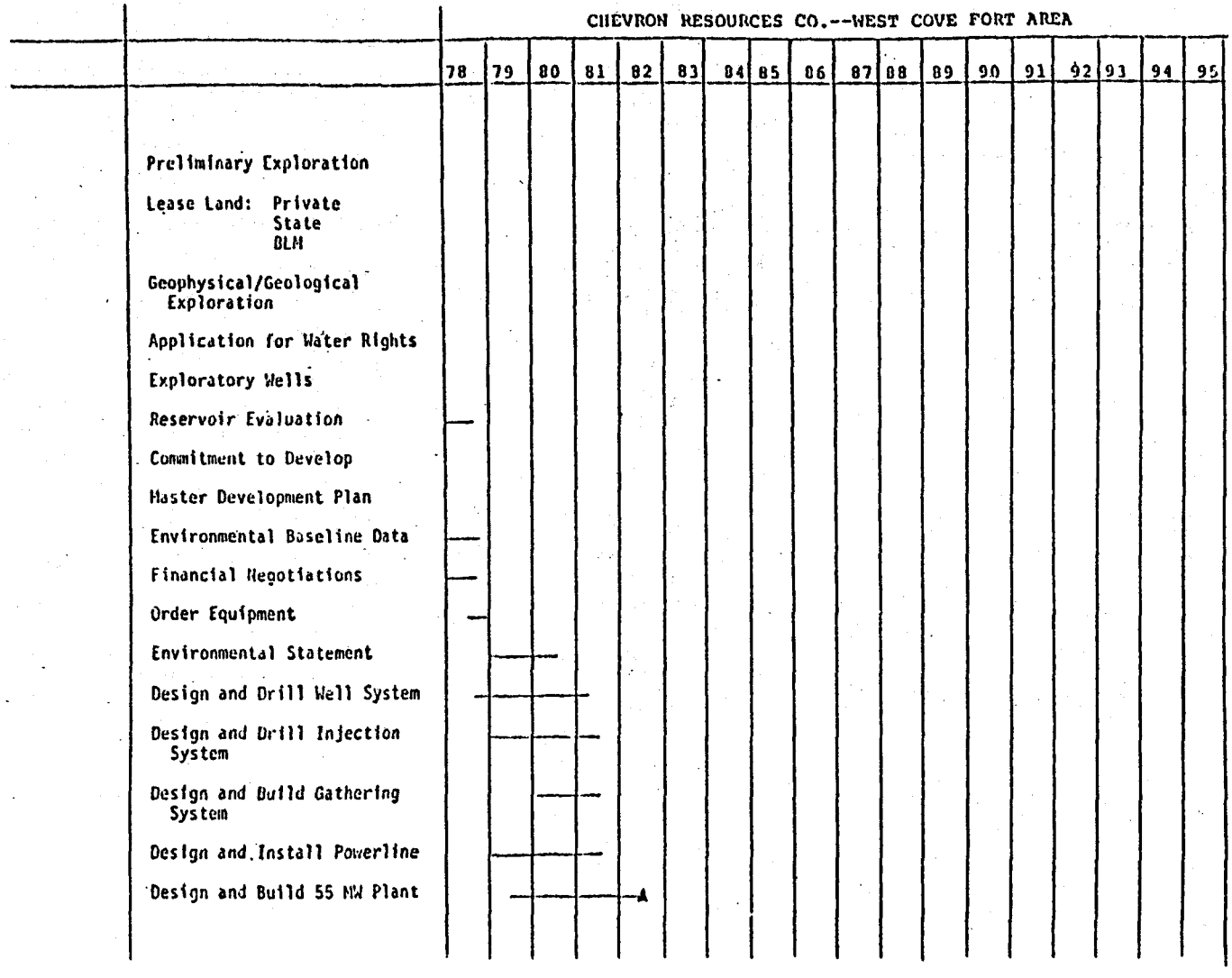
Continued

same drilling difficulties encountered in the production drilling will slow the injection system somewhat.

11. It was assumed that the design and construction of the gathering system will take about two years, and that it will be completed several months after the production well system has been completed.

12. Utah Power and Light has a 138 KV powerline near Cove Fort, about six miles south of the Hunt prospect. In addition, if Roosevelt and Cove Fort begin producing power, UP&L may build a power line serving these areas even closer to the Hunt Prospect.

13. Construction and design of the power plant was assumed to take about three years, with the actual construction taking about two years. The power plant was estimated to be completed about 1985.


CHEVRON RESOURCES CO.--WEST COVE FORT AREA
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Preliminary Exploration
Lease Land: Private
State
BLM
Geophysical/Geological Exploration
Application for Water Rights
Exploratory Wells
Reservoir Evaluation
Commitment to Develop
Master Development Plan
Environmental Baseline Data
Financial Negotiations
Order Equipment
Environmental Statement
Design and Drill Well System
Design and Drill Injection System
Design and Build Gathering System
Design and Install Powerline
Design and Build 55 MW Plant
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Summary: West Cove Fort Prospect (Chevron Resources Co.)

No deep exploratory drilling has been done in the desert area west of Cove Fort and north of the Roosevelt prospect. However, several groups have done exploratory work in that area, including geophysical investigations and temperature gradient surveys. The area is covered mostly by lake deposits with scattered late Tertiary volcanic outcroppings. Meadow and Hatton warm springs occur along the east edge of the desert.

Chevron Resources has extensive holdings through this area, including a large contiguous block of state, federal, and fee leases. Chevron has conducted exploratory work, but as mentioned above, no exploratory wells have been drilled and no reservoir has been verified.

For purposes of the planning scenarios, it was assumed that a commercial discovery will be made. This does not constitute an estimate by the developer but rather is an assumption for planning purposes. It was assumed that if a commercial discovery were made and no unforeseen technical or institutional problems arose, a power plant could come on line within five to seven years of the discovery.

Specific Assumptions: West Cove Fort (Chevron Resources Company)

1. It was assumed that most of the preliminary exploration and the leasing of state, private, and federal lands has been completed.

2. It was assumed that geophysical and geological exploration, including temperature gradient wells and stratigraphic holes, will continue for a few years. These exploratory activities were assumed to continue after the initial exploratory wells have been drilled.

3. It was assumed that deep exploratory drilling will begin later in 1978. This assumption implies no commitment or planning on the part of Chevron Resources. Its only purpose is to provide a frame of reference and a starting point for the development scenario. Again, this does not imply that Chevron has any specific plans to drill in any area at any time.

4. The reservoir evaluation was assumed to take place over about a 1½ year period after two or three wells have been drilled confirming the discovery well. This includes intensive well tests and long-term reservoir tests.

5. The commitment to development was assumed to come at a point after the reservoir has been fairly well verified and the utility is convinced of the economic advantage of the project, about two to three years after the discovery well.

6. The master development plan was assumed to be initiated at about the time that the commitment to develop is made, and was assumed to extend about a year.

7. The gathering of one year's environmental baseline data was assumed to begin as the commitment to develop becomes secure.

8. Financial negotiations were assumed to begin at the time of the commitment to develop, perhaps somewhat previous, and to continue for about a year, perhaps less.

9. It was assumed that some of the generating equipment will be ordered three to four years before the facility is scheduled for completion, or shortly after the commitment to develop.

10. The environmental statement was assumed to take about 1-1½ years to complete, and was assumed to begin about the time that the baseline environmental data had been completed.

11. The designing and drilling of the production well system was assumed to begin six months to one year after the commitment to develop and to continue about 2½ years.

Continued

It was assumed to be completed about a year before the facility is scheduled for completion.

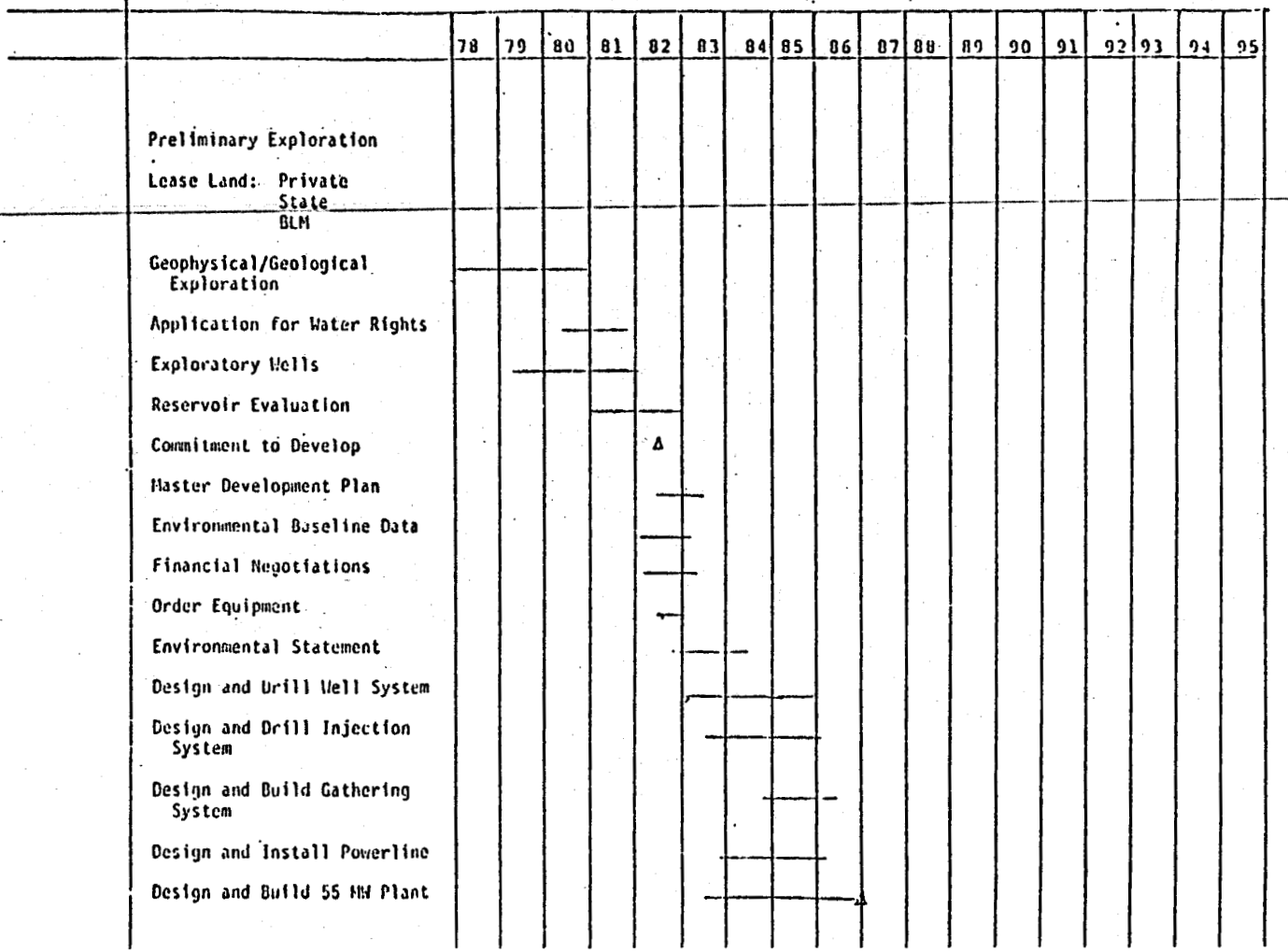
12. The injection system design and drilling was assumed to begin a few months after the production well system and to continue until a few months after the production well system is completed, or about two years.

13. The design and drilling of the gathering system was assumed to take about 1-1½ years and to be completed a few months after the completion of the injection system.

14. There are no power lines through this area at the present time. If the power line to the Roosevelt prospect goes to the existing line at Cove Fort by the shortest route, it will be necessary to build another line for any West Cove Fort prospects. If the power line from Roosevelt goes north, it could well pass through the West Cove Fort area and reduce the required power line distances for prospects north of Roosevelt. For purposes of the scenario, it was assumed that a new power line will be necessary and that it will take about 2½-3 years to complete.

15. The design and construction of the power plant was assumed to take about three years; the completed plant was assumed to come on line about 1985.

Possible Development Forecast: West Cove Fort Area (AMAX Exploration, Inc.)



Summary: West Cove Fort Area (AMAX Exploration, Inc.)

No deep exploratory drilling has been done in the desert area west of Cove Fort and north of the Roosevelt prospect. However, several groups have done exploratory work in that area, including geophysical investigations and temperature gradient surveys. The area is covered mostly by lake deposits with scattered late Tertiary volcanic outcroppings. Meadow and Hatton warm springs occur along the east edge of the desert.

AMAX Exploration, Inc., has scattered lease holdings throughout the West Cove Fort/North Roosevelt area and extensive leases in the Thermo area. AMAX has conducted some geophysical and geological exploratory work, particularly temperature gradient holes. No exploratory wells have been drilled on AMAX's holdings in either area, and no reservoir has been verified.

For purposes of the planning scenarios, it was assumed that a commercial discovery will be made. This does not constitute an estimate by the developer but rather is an assumption for planning purposes. It was assumed that if a commercial discovery were made and no unforeseen technical or institutional problems arose, a power plant could come on line within six to eight years of the discovery.

Specific Assumptions: West Cove Fort Area (AMAX Exploration, Inc.)

1. It was assumed that most of the preliminary exploration and the leasing of state, private, and federal lands has been completed.

2. It was assumed that geophysical and geological exploration including temperature gradient wells and statigraphic test holes will continue for several years. These exploratory activities were assumed to continue after the initial exploratory wells have been drilled.

3. It was assumed that deep exploratory drilling will begin late in 1978 or 1979. This assumption implies no commitment or plans on the part of AMAX Exploration. Its only purpose is to provide a frame of reference and a starting point for the development scenario. Again, this does not imply that AMAX has any specific plans to drill in any area at any time.

4. The reservoir evaluation was assumed to take place over about a two-year period after three to five wells have been drilled confirming the reservoir. This includes intensive well tests and long-term reservoir tests.

5. The commitment to development was assumed to come at a point after the reservoir has been fairly well verified and the utility is convinced of the economic advantage of the project, about two to three years after the discovery well.

6. The master development plan was assumed to be initiated at about the time that the commitment to develop is made, and was assumed to extend about a year.

7. The gathering of one year's environmental baseline data was assumed to begin as the commitment to develop becomes secure.

8. Financial negotiations were assumed to begin somewhat before the commitment to develop is made and to continue for about a year.

9. It was assumed that some of the generating equipment will be ordered three to four years before the facility is scheduled for completion, or shortly after the commitment to develop.

10. The environmental statement was assumed to take about 1-1½ years to complete, and was assumed to begin about the time that the baseline environmental data had been completed.

11. The design and drilling of the production well system was assumed to begin six months to one year after the commitment to develop and to continue about 2½ years. It was assumed to be completed about a year before the facility is scheduled for completion.

Continued

12. The injection system design and drilling was assumed to begin a few months after the production well system and to continue until a few months after the production well system is completed, or about two years.

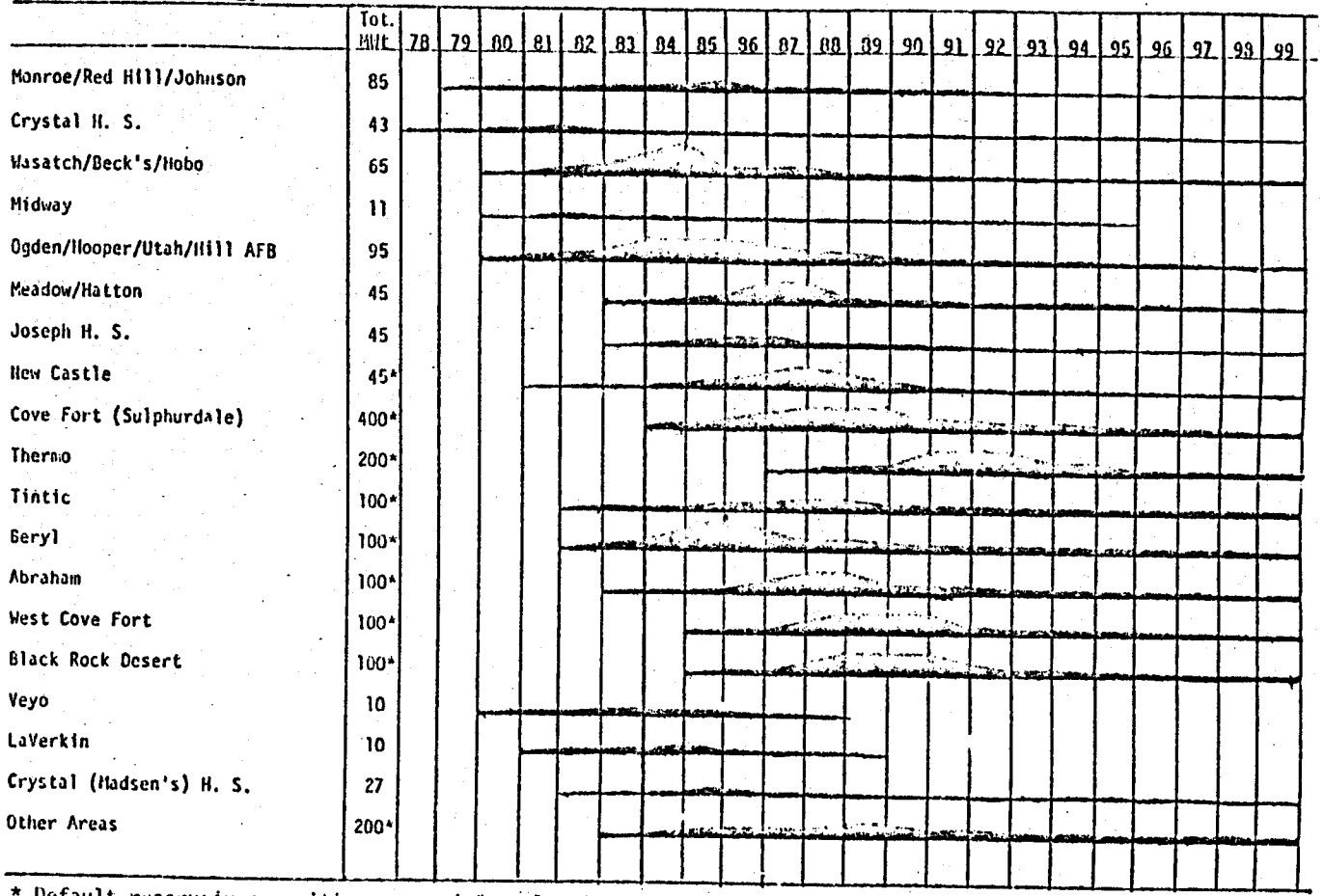
13. The design and drilling of the gathering system was assumed to take about 1-1½ years and to be completed a few months after the completion of the injection system.

14. There are no power lines through this area at the present time. If the power line to the Roosevelt prospect goes to the existing line at Cove Fort by the shortest route, it will be necessary to build another line for any West Cove Fort prospects. If the power line from Roosevelt goes north, it could well pass through the West Cove Fort area and reduce the required power line distances for prospects north of Roosevelt. For purposes of the scenario, it was assumed that a new power line will be necessary and that it will take about 2½-3 years to complete.

15. The design and construction of the power plant was assumed to take about three years; the completed plant was assumed to come on line about 1987.

Postulated Geothermal Direct Use Development Profile for Utah
(New development each year, MWt)

Approximate Scale 10 MWt



* Default reservoir capacities assumed for planning purposes.

AGGREGATED SCENARIO--DIRECT UTILIZATION OF GEOTHERMAL RESOURCES IN UTAH

	Tot. MWt	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
Monroe/Red Hill/Johnson	85		1	1	1	2	2	3	4	2	2	1	1	1	1		1		1		1		1
Crystal H. S.	43	1	1	2	4	2	2	1	1	1	1	1		1		1		1		1		1	
Wasatch/Deck's/Hobo	65			1	3	5	10	15	5	5	5	2	2	1	1	1	1		1		1		1
Midway	11			1	2	1	1	1		1		1		1		1		1					
Ogden/Hooper/Utah/Hill AFB	95			2	3	5	10	10	10	7	5	5	3	2	2	2	2	2	1	1	1	1	
Meadow/Hatton	45						1	2	4	10	10	3	2	2	1	1	1	1		1		1	
Joseph H. S.	45						1	2	4	4	2	2	1	1	1	1	1		1		1		1
New Castle	45*					1	1	2	4	7	10	8	4	2	1	1		1		1		1	
Cove Fort (Sulphurdale)	400*							2	4	7	10	10	10	5	5	3	3	3	3	3	3	2	2
Thermo	200*										1	2	4	10	10	10	5	5	3	3	3	3	2
Tintic	100*					2	2	2	4	4	5	5	4	3	3	3	3	3	3	3	3	2	2
Beryl	100*					2	4	10	15	10	5	5	5	4	3	3	3	3	2	2	2	2	2
Abraham	100*						1	1	2	6	10	10	5	4	4	3	3	3	3	3	2	2	2
West Cove Fort	100*								2	2	6	10	10	10	5	3	3	2	2	2	2	2	2
Black Rock Desert	100*								2	2	6	10	10	10	5	3	3	2	2	2	2	2	2
Veyo	10			1	1	2	2	1	1	1	1												
LaVerkin	10				1	1	2	2	1	1	1	1											
Crystal (Madsen's) H. S.	2/					1	1	2	4	2	2	1	1		1		1		1		1		1
Other Areas	200*						1	2	4	4	4	6	6	4	4	2	2	2	2	2	2	2	2
Total for Year		1	2	8	15	24	41	58	71	76	86	83	68	61	47	38	32	29	25	24	24	21	20
Cumulative Total		1	3	11	26	50	91	149	220	296	382	465	533	594	641	679	711	740	765	789	813	834	854

Continued

	Tot. MWt	2000	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
Monroe/Red Hill/Johnson	85		1		1		1		1		1		1		1		1		1		1	
Crystal H. S.	43	1		1		1		1		1		1		1		1		1		1		1
Wasatch/Beck's/Hobo	65		1		1		1		1													
Midway	11																					
Ogden/Hooper/Utah/Hill AFB	95	1		1		1		1		1		1		1		1		1		1		1
Meadow/Hatton	45	1		1		1		1		1												
Joseph H. S.	45		1		1		1		1		1		1		1		1		1		1	
New Castle	45*	1																				
Cove Fort (Sulphurdale)	400*	2	2	2	1	1	1	1	1	1	1	1		1		1		1		1		
Thermo	200*	2	1	1	1	1	1		1		1		1		1		1		1		1	
Tintic	100*	2	1	1	1	1		1		1		1		1		1		1		1		1
Beryl	100*	1	1	1	1	1	1	1	1		1		1		1		1		1		1	
Abraham	100*	2	2	1	1	1	1	1		1		1		1		1		1		1		1
West Cove Fort	100*	2	2	1	1	1	1	1	1		1		1		1		1		1		1	
Black Rock Desert	100*	2	2	1	1	1	1	1		1		1		1		1		1		1		1
Veyo	10																					
LaVerkin	10																					
Crystal (Madsen's) H. S.	27		1		1		1		1		1		1		1		1					
Other Areas	200*	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total for Year		19	17	13	13	12	12	11	10	9	9	8	8	8	8	8	8	8	7	8	7	8
Cumulative Total		873	890	903	916	928	940	951	961	970	979	987	995	1003	1011	1019	1027	1035	1042	1050	1057	1065

Low Temperature Geothermal Uses: General Assumptions

1. The reservoir energy potentials for most of the sites (the spring areas) were taken from the Core Team estimates of reservoir thermal potential. These estimates are based on the following assumptions:

   A. Reservoir temperatures were taken from chemical or physical data in USGS Circular 726 /8/ and as provided by Dr. Swanberg /1/.

   B. A standard reservoir volume was assumed, as used in USGS Circular 726, of 2.25 km^3 /8/.

   C. Stored heat and thermal potential are calculated from these values with weighting factors from USGS Circular 726. This factor is the recovery factor, 0.06, found on p.116 /8/.

2. Any postulated development is, of course, dependent on the presence of suitable resources. Development in most cases was assumed to be gradual at first. Rates of development and relative magnitudes of energy use were estimated from the following factors:

   A. Known plans for development, as ascertained through literature or verbal communications (see references).

   B. Probable or potential uses, such as greenhouses, mining, etc.

   C. Proximity to areas of potential use, or conversely, relative isolation.

   D. General potential of the prospect, including such factors as temperature, heat content, flow, dissolved solids, etc.

   The potential MWt (for 30 years) was proportioned over a seemingly reasonable period based on the above factors.

3. As an approximate quideline, rates and magnitudes of development were based loosely on an estimate of about 1 MWt for a greenhouse of 2050 m^2 /2/.

4. Some areas which were not included in the Core Team Report were assigned a reservoir potential on a purely arbitrary basis. These capacities are noted with an asterisk (*) on the scenarios and other places.

5. The most probable sites were treated individually. The potential for the rest of the state, incuding less likely known sites and currently unknown sites, were assigned an arbitrary value (see the assumptions for this prospect).

6. Estimates are admittedly optimistic. Neither individual magnitudes nor rates can be considered to be reflections of the real situation. The scenarios usually reflect more what could be rather than what will be, even according to present plans.

Continued

7. Individual scenarios are not intended to be accurate reflections of real development as much as a basis for the aggregated scenarios. Thus, the aggregated scenarios are probably of more worth than the individual scenarios.

8. The estimated development times have been estimated without regard to development lag times or institutional factors, for the following reasons:

   A. Institutional factors are still very vague and vary greatly. Time will not permit extensive scenarios for each individual site at this point in the study.

   B. Even if average lag times were known for the specific steps required at each site, the procedure for developing scenarios would involve estimating a date for development and then working backwards. At this point, the basic results would be the same.

   C. It is to be hoped that the "semi-continuous" approach to the scenarios makes up for some of the specific inaccuracies in the time schedules.

9. It was assumed for all cases that development will be reasonably feasible from economic and technical standpoints.

10. Dissolved solids data are averages of the samples cited in WRB-13 (Reference 6).

Prospect: Monroe Hot Springs
(Also Red Hill, Johnson Hot Springs)

Resource Characteristics:

Surface Fluid Temperature: Monroe 76°C, Red Hill 77°C, Johnson's 25°C /6/

Subsurface Fluid Temperature: Monroe 120°C, Red Hill 135°C /1/

Total Dissolved Solids: Monroe 2750 ppm, Red Hill 2630 ppm, Johnson 428 ppm /6/.

Estimated Energy Potential: Monroe 38 MWt, Red Hill 43 MWt, Johnson 4 MWt for 30 years Total: 85 MWt /1/

Type of Overlying Rocks: Springs issue from tufa mounds along the base of the mountain /6/, grading west into alluvium in the valley.

Location of Prospect: Just east of Monroe, Utah; T25S, R3W, Sec. 11, 15, and 27 /6/.

Description: Series of hot springs issuing from hillside immediately east of Monroe City, at the base of a large mountain. The springs are along a north-south trending fault /6/.

Land Ownership: Mostly Private /2/. Some BLM and National Forest Lands east of the prospect /11/.

Land Use: Municipal, agricultural, range land, and forest land nearby.

Leasing: Some leasing in area. Limited leasing because most of the land is private /12/.

Activity:

The springs are presently being used by a spa for heating a swimming pool, showers, etc. The owners have expressed plans for eventually heating greenhouses and a motel complex.

The City of Monroe has received conditional approval on a proposal for a space heating system for the city. The first phase of this project would involve the heating of the South Sevier District High School; later the system would be expanded to heat homes in the city as well as several larger buildings in the city, a number of greenhouses, and several multiple unit complexes (motels and apartments).

Assumptions:

1. Geothermal Resources are at this time being used to heat a spa and resort. The Monroe City development will probably drill a well late in 1978 or early in 1979. Use of the water will begin shortly thereafter to heat the school.

2. The development outlined in the Monroe proposal was assumed to utilize about 8 MWt, and will be developed up to about 1981.

3. Development beyond 1981 will likely continue. Some of the development will be in houses and homes, but it will probably include more greenhouses and other agricultural/light industrial uses.

4. Development will probably depend a lot on reservoir characteristics, which will not be accurately determined until development actually begins. Thus, the development will probably proceed step-wise over a number of years.

Prospect: Crystal Hot Springs

Resource Characteristics:

Surface Fluid Temperature: 58°C /6/

Subsurface Fluid Temperature: 80°C /3/

Total Dissolved Solids: 1520 ppm /6/

Estimated Energy Potential: 43 MWt for 30 years /1/

Type of Overlying Rocks: Unconsolidated valley fill. Bedrock at fairly shallow depths. Volcanic rocks underlie the fill /6/.

Location of Prospect: South end of Salt Lake Valley, near "Point of the Mountain." Area near T4S, R1W, Sec. 12, NW¼ /6/.

Description: Series of Hot Springs discharging into clear pools and ponds.

Land Ownership: Some private (Mr. Dunyon)/3/; also, the state owns some land in the immediate vicinity, including the State Prison Complex.

Land Use: Some agricultural, few greenhouses, fish culture; State Prison; Div. of Forestry has some land just south of the prison which maybe used for silviculture /3/.

Leasing: No state or federal leases; lands unavailable for leasing.

Activity: Some discharge from the springs is used by Mr. Dunyon for use in raising tropical fish /3/.

During January and February, 1978, the Utah Geological and Mineral Survey drilled a series of temperature gradient wells near the site under the State Cooperative Program.

In connection with the temperature gradient holes, the Utah Division of Forestry plans to drill a test well near the prison which, if producible, could be used to heat greenhouses. Eventual uses in the area could include more greenhouses, heating for housing developments, and space heating for the State Prison.

As a result of the temperature gradient survey, the State Forester's Office drilled a well to be used as a source of heat for a silviculture project.

Assumptions:

1. It is assumed that development will begin slowly as the reservoir parameters are explored. If the reservoir proves adequate, more greenhouses will be added and the prison will consider space heating. Because construction of houses or retrofitting of the prison will take some time, the peak of the development will probably be spread over several years. After the main peak of utilization has passed, additional development will probably occur as the limits of the reservoir are explored.

2. No attempt has been made to represent accurately the magnitudes of heat necessary for heating the prison. The estimated available energy has merely been apportioned over a reasonable interval.

3. The estimated development times have been estimated without regard to development times or institutional factors, for the following reasons:

   A. Institutional factors are still very vague and vary greatly. Time will not permit extensive scenarios for each individual site.

   B. Even if average lag times were known for the specific steps required at each site, the procedure for developing scenarios would involve estimating a date for development and then working backwards. At this point, the basic results would be the same.

   C. It is to be hoped that the "semi-continuous" approach to the scenarios makes up for some of the specific inaccuracies in the time schedules.

Prospect: Wasatch Hot Springs/Beck's Hot Springs/Hobo Hot Springs /3/

Resource Characteristics:

Surface Fluid Temperature: Wasatch 42°C, Beck's 56°C /6/

Subsurface Fluid Temperature: Wasatch 120°C /1/, Beck's 90°C /1/

Total Dissolved Solids: Beck's 13,400 ppm, Wasatch 7220 ppm /6/

Estimated Energy Potential: Wasatch 38 MWt/30 years, Beck's 27 MWt/30 years /1/.

Type of Overlying Rocks: Both springs issue near the contact between Quaternary Valley fill and Paleozioc limestones /6/.

Location of Prospect: Salt Lake Valley near the north end of Salt Lake City. T1N, R1W; Beck's, Sec. 14, SW¼SE¼. Wasatch, Sec. 25, NW¼SE¼ /6/.

Description: Hot springs along Wasatch Fault, along east edge of Salt Lake Valley between Salt Lake City and Bountiful City.

Land Ownership: Mostly private (within city) /11/.

Land Use: Grades from residential and commercial near Wasatch Springs to light and heavy industry north from Beck's Springs.

Leasing: No federal or state leases in the vicinity of the springs.

Activity:

At one time, Wasatch H.S. and Beck's H.S. were used for spas. However, neither is presently being used, and Beck's is discharging large amounts of hot water to a canal leading to Great Salt Lake. Some warm waters in the area are used for washing gravel by gravel companies in the area.

Assumptions:

1. Although the hot springs discharge is not being used at this time, the proximity of the springs to the city center and industrial areas makes them prime targets for development. Several parties have inquired about the use of warm water in the area for space heating. For these reasons, development is expected to begin within the next

Continued

few years, and to continue thereafter as interest grows. At least two buildings in Salt Lake City area are using heat pump applications in connection with heating and cooling. (The buildings are the LDS Church Office Building in the downtown area and the International Center near the Salt Lake Airport) /3/. Because of the general area of the springs much of the development was assumed to be primarily light industrial or large space heating uses.

2. Development rates, times, and magnitudes are arbitrary but reasonable estimates.

Prospect: Midway Hot Springs

Resource Characteristics:

Surface Fluid Temperature: 45°C /1,6/

Subsurface Fluid Temperature: 43°C /3/

Total Dissolved Solids: 1770 ppm /6/

Estimated Energy Potential: 11 MWt (based on surface temp.)/1/

Type of Overlying Rocks: The springs issue from calcerous tufa about 70 ft. thick, underlain by alluvium /6/.

Location of Prospect: In the area of T3S, R4E, Section 26, 27, 34, 35, in the northwest corner of the Heber Valley /6/.

Description: Numerous hot springs with tufa mounds. The springs drain into Snake Creek above Midway.

Land Ownership: Mostly state and private lands /11/.

Land Use: Mostly agricultural, also residential, and recreational (Wasatch Mountain State Park, etc.).

Leasing: Some state and/or federal leasing in Heber Valley, but not in the vicinity of the springs /12/.

Activity:

Several of the large springs have been used for several years as water for swimming pools and resorts.

There have been a few inquiries regarding the use of geothermal fluids for space heating; however, nothing is definite or specifically planned at this time.

The Utah Geological and Mineral Survey drilled five temperature gradient holes in the Midway area in April and May, 1978. Water at a temperature of 109°F (43°C) was encountered. The tufa was found to be underlain by alluvium, which in turn was underlain by fractured quartzite. One of the temperature gradient wells hit artesian pressure, and flowed at a rate of 400-600 gpm. Springs in the area of the hole were affected almost immediately, indicating very rapid communication within the aquifer.

Assumptions:

1. Midway H.S. are near the small town of Midway, but there are at this time only a school and town hall which could be major users of geothermal heat. Development would probably take the form of greenhouses and/or housing developments such as apartments or condominiums.

Continued

There is a fish hatchery near Midway but it is several miles from the hot springs area. Development was estimated to begin about 1980 on a small scale and to extend over several years.

2. Development rates, times, and magnitudes are arbitrary but reasonable estimates.

Prospect: Ogden Area: Ogden H.S., Utah H.S., Hooper H.S., Hill AFB

Resource Characteristics:

Surface Fluid Temperature: Ogden H.S. 58°C, Hooper H.S. 60°C, Utah 58°C /6/

Subsurface Fluid Temperature: Ogden H.S. 110°C, Hooper H.S. 105°C, Utah H.S. 95°C /1/

Total Dissolved Solids: Ogden H.S. 8700 ppm, Hooper 8800 ppm., Utah 18,600 ppm /6/

Estimated Energy Potential: Ogden H.S. 34 MWt/30 yr., Hooper H.S. 32 MWt/30 yr., Utah H.S. 29 MWt/30 yr. Total 95 MWt/30 yr /1/.

Type of Overlying Rocks: Ogden H.S. rise along a fault in Precambrian rocks; Hooper H.S. rise from Quaternary Valley fill; Utah H.S. issue in an area of complex faulting in Cambrian rocks /6/.

Location of Prospect: Ogden H.S. T6N, R1W, Sec. 23, SW¼SW¼; Hooper H.S. T5N, R3W, Sec. 27, SW¼; Utah H.S. T7N, R2W, Sec.14, SW¼SE¼. Generally east, west, and north of Ogden respectively /6/.

Description: Various hot springs; Utah H.S. is used for greenhouses, Ogden is a diffuse spring area, Hooper is not used at the present time /3,6/.

Land Ownership: Mostly private. Hooper H.S. is near the wildlife refuge /11/. Hill AFB is federal reserve land /7/.

Land Use: Mostly municipal. The actual spring areas are away from the city. Hooper is in an agricultural area, and Utah H.S. is in an agricultural and light industrial area.

Leasing: No federal or state leases in this area /12/. (No federal or or state lands) /11/.

Activity: Utah H.S. is currently being used to heat greenhouses by the Allen Plant Co. and another company/3/. There is a lot of iron in the water /3,6/. There appear to be plans for further development.

Ogden H.S. was used as a resort, now is being discharged as runoff. The water is hot, but the source is diffuse, posing possible tapping problems. Water is quite mineralized /3/.

Continued

Hooper water is hot, but the spring is some distance from population areas and is currently not being used /3/.

Hill AFB at Ogden contracted to EG&G to do a study on the possibility of heating buildings on the base with geothermal fluids /7/. No particular geothermal resources are known to be beneath the base, but a major fault does run through the base area and might possibly provide a conduit for hot fluids beneath the base.

Assumptions:

1. The magnitude of the resource was assumed to be equal to the sum of the estimated potential for the three spring areas. This assumption is obviously not accurate since the estimate was applied over the whole area, including Hill AFB. However, no other data is available. Again, magnitudes, times, and growth rates are only rough guesses.

2. Development was assumed to start small, with existing uses (resorts and greenhouses), and to begin in the early 80's as the feasibility of geothermal uses are proven. Development of geothermal heating for Hill AFB was assumed to be possible and feasible, so that development there would begin about 1982 to 1984, an optimistic estimate. Because most of the buildings would require retrofitting, etc., development at the air base was assumed to proceed step-wise over a number of years.

Prospect: Meadow/Hatton Hot Springs

Resource Characteristics:

Surface Fluid Temperature: Hatton H.S. 38°C /1,6/, Meadow 41°C /6/

Subsurface Fluid Temperature: Meadow H.S. 105°C /1/

Total Dissolved Solids: Meadow 4800 ppm, Hatton 4760 ppm /6/

Estimated Energy Potential: Meadow 37 MWt/30 yr., Hatton 8 MWt/30 yr. /1/

Type of Overlying Rocks: The springs are in valley fill of Tertiary or Quaternary age; There are Quaternary basalt flows within a few miles of the Springs /6/.

Location of Prospect: Near Meadow and Hatton in Beaver Co. Meadow H.S. T22S, R6W, Sec. 26, SW¼SW¼; Hatton, T22S, R6W, Sec. 35, SE¼SE¼ /6/.

Description: The spring areas are west of Hatton in a semi-arid range area. Hatton spring no longer flows /6/.

Land Ownership: Mostly private, some federal lands in area /11/.

Land Use: Agricultural, range and desert.

Leasing: State and federal leasing in area /12/.

Activity: Meadow Hot Springs is a relatively new spring, now being used for stock watering /3/.

Hatton Hot Springs no longer flows /6/.

Assumptions:

1. Meadow and Hatton Hot Springs are some distance from the towns of Meadow and Hatton /3,6/. Because of this slight isolation, development of the spring areas per se will probably not occur until the early or mid 1980's, and probably will start out with a few greenhouses or similar agricultural or light industry.

2. Immediate area of the springs is of questionable geothermal potential because of the relatively low temperature of the spring water, the low silica content, and the similarity in chemical quality to the ground water in a fairly large surrounding area /6/.

Continued

However, the springs are in an area of late Tertiary and Quaternary volcanic flows. Some lands in the area have been leased for Geothermal development. It is likely therefore that the geothermal potential of the area is not confined to the springs area. This leads to the possibility that geothermal development could occur much nearer to the cities of Meadow, Hatton, and Kanosh, and perhaps over a larger area. However, because this type of development would require drilling and is somewhat more risky, it would probably be delayed until the middle or late 1980's and may be related to attempts to locate resources suitable for electrical production.

3. The estimates of magnitude of recoverable energy for the area is the sum of the estimates for the springs, even though the potential extends beyond the spring area. Development rates, times, and relative magnitudes are arbitrary but reasonable estimates.

Prospect: Joseph Hot Springs

Resource Characteristics:

Surface Fluid Temperature: 64°C /6/

Subsurface Fluid Temperature: 162°C /1/

Total Dissolved Solids: 5100 ppm /6/

Estimated Energy Potential: 45 MWt/30 yr. /1/

Type of Overlying Rocks: Joseph Hot Springs issues from a tufa mound over the Dry Wash fault. Immediately east of the fault there are extensive volcanic outcroppings of late Tertiary age. On the other side of the fault are unconsolidated Quaternary deposits /6,13/.

Location of Prospect: T25S, R4W, Section 23, Southeast of the town of Joseph in Sevier County, Utah /6/.

Description:

Land Ownership: Mostly private in the valley, surrounded by BLM land east of the main valley /11/.

Land Use: Agricultural, range land, and rural residential.

Leasing: Leasing has occurred in the immediate area of the springs and of the town of Joseph /13/.

Activity: Spring Area, very low discharge. No known development activity.

Assumptions:

1. Joseph Hot Spring has a relatively low discharge. On the one hand, this may indicate a lower recharge rate (suggested by Ref. 3); on the other hand, it may be due to sealing action by precipitates and may be a pressurized system (suggested by Ref. 5). Although the evident recharge area is not as large as that of Monroe Hot Springs a few miles away, the Joseph Hot Springs are located on a long fault, which may extend up along the Sevier River /6/. It is quite apparent that the magnitude of the resource will only be determined by exploratory drilling. For the purposes of the scenario, the estimated magnitude of the resource as determined by USGS Circular 726 was used /1,8/. Development rates, times, and magnitudes are reasonable estimates only.

Continued

2. The hot springs area is about a mile from Joseph. In order to make a community space heating system feasible, it would pretty much be necessary for larger heat loads to be located at the far end of a distribution line. This would put the load about 1½ miles from the spring area. Three factors might change this situation:

   A. Wells might be drilled away from the springs area. However, this would involve more geophysical exploration and because of the greater risk, might not be feasible at all.

   B. Greenhouses or other similar industry might be located between the springs and the town. Although this would be more feasible, it would not provide the loads in the city which would make space heating for residences feasible.

   C. It may become feasible to transport the heat longer distances.

   In any of these cases, development would probably not gain very much momentum before the mid-1980's.

Prospect: New Castle

Resource Characteristics:

Surface Fluid Temperature:

Subsurface Fluid Temperature: 100-110°C

Total Dissolved Solids: Relatively low /3,4,5,9/.

Estimated Energy Potential: Not known; assumption of 40 MWt/30 yr. for planning purposes.

Type of Overlying Rocks: Most of the valley is overlain by Quaternary alluvium; within a few miles of New Castle there are outcroppings of late Tertiary volcanic rocks and Tertiary granites.

Location of Prospect: About T36S, R15W /11/.

Description: Agricultural area, with water wells which have hot water at shallow depths.

Land Ownership: Large block of state land to the east of New Castle, federal lands to the south and southwest, private lands to the west /11/.

Land Use: Agricultural, range land, and rural residential.

Leasing: Some leasing has occurred on state and federal lands in the vicinity of New Castle /12/.

Activity: A well which was drilled to provide water for irrigation hit hot water at shallow depths. The water is presently cooled and used for irrigation.

Assumptions:

1. The New Castle area is at present a moderate priority for temperature gradient exploration under the State Cooperative Program /3,4/. There are few dwellings in the area, but possibilities for light industry exist (greenhouses, crop drying, extending growing season). The water is very low in dissolved solids. Because one well has already been drilled and other exploratory work is planned, development may come in the early 1980's. The primary drawback would be the isolation of the area.

Prospect: Cove Fort (Sulphurdale)

Resource Characteristics:

Surface Fluid Temperature:

Subsurface Fluid Temperature:

Total Dissolved Solids:

Estimated Energy Potential: Not known; assumption of 400 MWt/30 yr. for planning purposes.

Type of Overlying Rocks:

Location of Prospect: West Central Utah near Cove Fort, about T25S, R6&7W. Commonly known as The Cove Fort or the Cove Fort Sulphurdale area.

Description: Low hills grading into mountains, sagebrush/juniper regime, quite arid.

Land Ownership: Some private, BLM, and National Forest.

Land Use: Range and forest.

Leasing: Extensive leasing of state and federal lands /12/.

Activity: Union has drilled two wells in this area, one of which caved in, and is now drilling a third well. The possibility exists that the area will not yield resources which would be suitable for electrical generation. Whether or not electrical generation is possible there is a good potential for direct utilization at the prospect. Drilling has been difficult, however, and may be too expensive for small projects.

A. Inquiries have been made and plans may be underway to use a cascading system. Potential uses would be greenhouses or other industrial uses /5/.

B. A specific use may be at the sulphur mining operations at Sulphurdale, where heat is required for the sulphur extraction process /5/.

Continued

Assumptions:

1. Although there may be some institutional restraints (part of the probable geothermal field is on Forest Land) /5/, the possibility of industrial use of geothermal heat appears good. The industrial use will probably coincide with the production of electrical power /5/.

2. The magnitude of the power in use will depend primarily on the resource. The estimate of 400 MWt for 30 years is an assumption based on estimates of the electrical potential for the area /9/.

3. It is assumed that once the geothermal resource has been proven that industrial use will be added in fairly large increments on a fairly regular basis.

Prospect: Thermo

Resource Characteristics:

Surface Fluid Temperature:

Subsurface Fluid Temperature:

Total Dissolved Solids:

Estimated Energy Potential: Not known; assumption of 200 MWt/30 yr. for planning purposes.

Type of Overlying Rocks:

Location of Prospect: West and south of Minersville, about T30&31S, R12&13W /11/.

Description: Mostly desert flat area, scrub vegetation.

Land Ownership: Mostly BLM, some state and federal land /12/.

Land Use:

Leasing: State and federal lands have been leased extensively /12/.

Activity: Republic Geothermal, Inc., has drilled a deep geothermal well in the area which is still being tested. Geophysical and temperature gradient exploration has also taken place quite extensively by Republic, AMAX, Chevron, and other developers.

Assumptions:

1. Although there have been no specific plans expressed for either cascading systems or purely industrial use, it is very likely that the resource will be suitable to direct utilization. This development will probably not occur until the mid or late 1980's for the following reasons:

   A. The general development of the Thermo area is several years behind the development for the Roosevelt and Cove Fort areas; this would put development at about the mid-1980's.

   B. The Thermo area is quite isolated and this fact will probably account for some retardation of development.

2. The magnitude of the heat potential for this prospect is an assumption and hopefully reasonable; the development times, rates, and magnitudes are more arbitrary estimates.

Prospect: Tintic

Resource Characteristics:

Surface Fluid Temperature:

Subsurface Fluid Temperature:

Total Dissolved Solids:

Estimated Energy Potential: Not known; assumption of 100 MWt/30 yr. for planning purposes.

Type of Overlying Rocks: Alluvium, tertiary pyroclastics /13/.

Location of Prospect: T10&11S, R2&3W, south of Utah Valley in the center part of the state.

Description: The area is of volcanic origin and is mined extensively for metalliferous minerals. Hot water issues from the Burgin Mine and is discharged to a stream. It runs several miles down the canyon and is ponded in an evaporation pond.

Land Ownership: Private, BLM, and some state lands /11/.

Land Use: Some mining; agriculture in the valley area.

Leasing: Some state and federal lands leased /12/.

Activity: The Burgin Mine discharges hot water down from the Tintic Mountains to an evaporation pond. No use is presently made of the heat from the water. Some interest in the area has been expressed by exploration companies, and some leasing (state and federal) has taken place. Phillips Petroleum recently drilled a deep temperature gradient hole in the Tintic Mountains.

Assumptions:

1. Even though Kennecott, which uses the Burgin Mine, has at present no specific plans for utilization of the geothermal fluids which are discharged from the mine, it was assumed that Kennecott would become interested in the development of the resource, or that they would cooperate with a second party which could develop the resource. The water discharged from the mine could be either put through heat exchangers for industrial use near the mine or piped out of the mountains to sites where the terrain is more suitable to construction. There are no towns or housing areas near the mining area, but the presence of Goshen Warm Springs may indicate a general distribution of the resource through the valley.

2. The magnitude of the heat potential for this prospect was assumed for planning purposes; development time, rates, and magnitudes are arbitrary estimates.

Prospect: Beryl

Resource Characteristics:

Surface Fluid Temperature:

Subsurface Fluid Temperature:

Total Dissolved Solids:

Estimated Energy Potential: Not known; assumption of 100 MWt/30 yr. for planning purposes.

Type of Overlying Rocks: Mostly Quaternary alluvium and lake bed sediments /13/.

Location of Prospect: Southern Utah. South and west of Thermo Hot Springs; T33&34S, R16W, and surrounding area /11/.

Description:

Land Ownership: Mostly private, some state and federal lands /11/.

Land Use: Farming, rural, and residential.

Leasing: State and federal lands in the area have been leased /12/.

Activity: Utah Power and Light, in conjunction with McCulloch Oil and Geothermal Kinetics, drilled three deep exploratory wells in the general vicinity of Beryl. Although the wells were not suitable for electrical production, they were very suitable for low temperature uses /5,9,10/. Interest in the Beryl area has also been expressed by other parties /4/.

Assumptions:

1. The Beryl area is quite isolated, a factor which would tend to retard development. Development, when it occurs, will almost certainly be industrial, since there are so few buildings in the area which could be heated. On the other hand, three wells have already been drilled, and the companies involved are considering low temperature use /10/. For these reasons, development was estimated to begin in the early 1980's. Because industrial use is most likely, development was estimated to come on-line in moderately large increments.

2. The magnitude of heat content used for the scenario was assumed for planning purposes; the development times, rates, and magnitudes are arbitrary estimates.

Prospect: Abraham (Baker) Hot Springs

Resource Characteristics:

Surface Fluid Temperature: 82°C /6/.

Subsurface Fluid Temperature: 125°C /1/.

Total Dissolved Solids: 3500 ppm /6/.

Estimated Energy Potential: 39 MWt/30 yrs /1/. Assumption of heating capacity of the springs and surrounding area, for planning purposes: 100 MWt/30 yrs.

Type of Overlying Rocks: The springs issue from a tufa mound near a Quaternary basalt flow /6/.

Location of Prospect: The springs are located at T14S, R8W, Section 10 and 15 /6/; the surrounding area is all a potential resource area.

Description: The Abraham Hot Springs issues from a tufa mound near Fumarole Butte, an old volcanic vent (Quaternary basalt) /6/. Most of the water discharges to a slough area in the desert bottom.

Land Ownership: Mostly BLM, some state and private /11/.

Land Use: Mostly desert, some range, etc.

Leasing: KGRA area. Extensive leasing of federal and state lands /12/.

Activity: Leasing, geophysical exploration, and temperature gradient exploration has taken place in the area of the Abraham Hot Springs. Some of the discharge from the Springs is used for a spa-type resort. The heat content of the resource may be less than is now apparent (absence of boiling temperatures, relatively low silica content, large water discharge)/6/; drilling will probably be necessary to define the resource potential.

Assumptions:

1. The Abraham Springs area is quite isolated. However, the discharge from the springs themselves is copious and hot. Beyond use for bathing, development at the springs and in the surrounding area will probably be primarily light industrial. Development is estimated to begin in the mid-1980's and to gain momentum as more uses become feasible, technical and economical. Development may also be related to mining in the area.

Prospect: West Cove Fort Area

Resource Characteristics:

Surface Fluid Temperature:

Subsurface Fluid Temperature:

Total Dissolved Solids:

Estimated Energy Potential: Not known; assumption for planning purposes: 100 MWt/30 yr.

Type of Overlying Rocks: Alluvium, late Tertiary basalt and basaltic andesite flows /13/.

Location of Prospect: North of the Roosevelt Prospect. West of the Cove Fort area. About T24&25S, R7&8W /11,12/.

Description: Area of extensive volcanic activity; desert shrubland.

Land Ownership: Mostly BLM, some state and private /11/.

Land Use: Some agriculture; mostly range and desert.

Leasing: Extensive leasing on state and federal lands /12/.

Activity: Extensive leasing, with geophysical and temperature gradient exploration /12,14/.

Assumptions:

1. It appears that there are several possible areas for electrical production in Utah and the area near Black Rock or the "West Cove Fort Area" is a possible prospect. If water can be found at depth, the area could be a potential low-temperature geothermal prospect whether or not the resource is suitable for electrical production. The scenario is based on the assumption that hot water can be located in sufficient quantities to make development feasible.

2. The estimate of a resource potential of 100 MWt/30 yr.is an assumption for planning purposes; the development times, rates, and magnitudes are arbitrary estimates.

Prospect: Black Rock Desert.

Resource Characteristics:

Surface Fluid Temperature:

Subsurface Fluid Temperature:

Total Dissolved Solids:

Estimated Energy Potential: Not known; assumption for planning purposes: 100 MWt/30 yr.

Type of Overlying Rocks: Lake bed sediments, Quaternary basalt, and late Tertiary basalt and basaltic andesite flows/13/.

Location of Prospect: West of Cove Fort area, about T23&24S, R7&8W /12/.

Description: Area of extensive volcanic activity; desert shrubland.

Land Ownership: Mostly BLM, some state and private lands/11/.

Land Use:

Leasing: Extensive leasing on state and federal lands/12/.

Activity: Extensive leasing, with geophysical and temperature gradient exploration /12,14/.

Assumptions:

1. It appears that there are several possible areas for electrical production in Utah, and the area in the Black Rock Desert is a possible prospect. If water can be found at depth, the area could be a potential low-temperature geothermal prospect whether or not the resource is suitable for electrical production. The scenario is based on the assumption that hot water can be located in sufficient quantities to make development feasible.

2. The estimate of a resource potential of 100 MWt/30 yr. is an assumption for planning purposes; the development times, rates, and magnitudes are arbitrary estimates.

Prospect: Veyo, LaVerkin

Resource Characteristics:

Surface Fluid Temperature: Veyo 42°C, LaVerkin 42°C /1,6/.

Subsurface Fluid Temperature:

Total Dissolved Solids: Veyo 396 ppm , LaVerkin 9580 ppm /6/.

Estimated Energy Potential: Veyo 10 MWt/30 yr., LaVerkin 10 MWt/30 yr. /1/.

Type of Overlying Rocks: Veyo, Quaternary basalts. LaVerkin, Paleozoic limestone, along Hurricane fault /6/.

Location of Prospect: Veyo, the springs are at T40S, R16W, Sec. 6, NW¼SE¼SW¼, about 18 miles north-northwest of St. George in southern Utah. LaVerkin springs are at T41S, R13S, Sec. 25, about 18 miles east-northeast of St. George /6/.

Description:

Land Ownership: Veyo: private land immediately around Veyo; some state lands nearby, BLM controls most of the surrounding area /11/.
LaVerkin: Also mostly private, BLM lands nearby /11/.

Land Use:

Leasing: Some leasing in the Veyo area /12/.

Activity: Veyo Hot Springs is currently used as a swimming pool and spa. LaVerkin (Dixie) Hot Springs issue from the bed and banks of the Virgin River near LaVerkin.

Assumptions:

1. Veyo: It would be reasonable to expect that some further development will occur at Veyo even though the magnitude of the resource available appears to be limited. Interest has been expressed in including the area as part of the temperature gradient survey under the State Cooperative Program /9/. Development would probably not be of great magnitude; but it could come in the mid-1980's. Use will probably be space heating or light industrial (greenhouses, etc.). Development rates, times and magnitudes are arbitrary but reasonable estimates.

Continued

LaVerkin: These springs discharge directly into the Virgin River, and recovery and collection might be difficult. It would certainly require exploration and probably test wells to determine if the reservoir has potential. In any case, development probably will not come until mid or late 1980's. Development times, rates, and magnitudes are arbitrary but reasonable estimates.

Prospect: Crystal Hot Springs (Madsen's, Honeyville)

Resource Characteristics:

Surface Fluid Temperature: 56°C /6/

Subsurface Fluid Temperature: 90°C /1/

Total Dissolved Solids: 42,100 ppm /6/

Estimated Energy Potential: 27 MWt/30 yr. /1/

Type of Overlying Rocks: The springs issue from Paleozoic rocks along the Wasatch fault zone /6/, in Quaternary alluvium /13/.

Location of Prospect: The springs are located at about T11N, R2W, Sec. 29, NE¼SE¼, in Box Elder Co., about 10 miles north of Brigham City /6/.

Description: Hot springs, used for spa, along the Wasatch fault on the west face of the Wasatch Mountains. The flow from the springs flows in Salt Creek, which flows through an agricultural area /6/.

Land Ownership: Mostly private. Forest lands in the area to the east, in the mountains.

Land Use: Mostly agricultural. The town of Honeyville is a few miles south of the spring area /6/.

Leasing: No leasing of state or federal lands in area /12/.

Activity: Crystal Hot Springs is presently used for a swimming pool, and the possibility exists for space heating /3/.

Assumptions:

1. It was assumed that interest in the geothermal potential will grow, and it seems reasonable that development will start in the early or mid-1980's.

2. It was assumed that the resource is adequate for space heating or light industry; development time, rates, and magnitudes are arbitrary but reasonable estimates.

Prospect: Other Areas (Includes other springs and other potential areas).

Assumption: The main assumption was that the other areas are generally remote and/or of small magnitude. Development at most of these areas will probably be after the mid-1980's, and will probably come in small increments. Again, the magnitudes used for the scenario are only a reasonable estimate.

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APPENDIX C

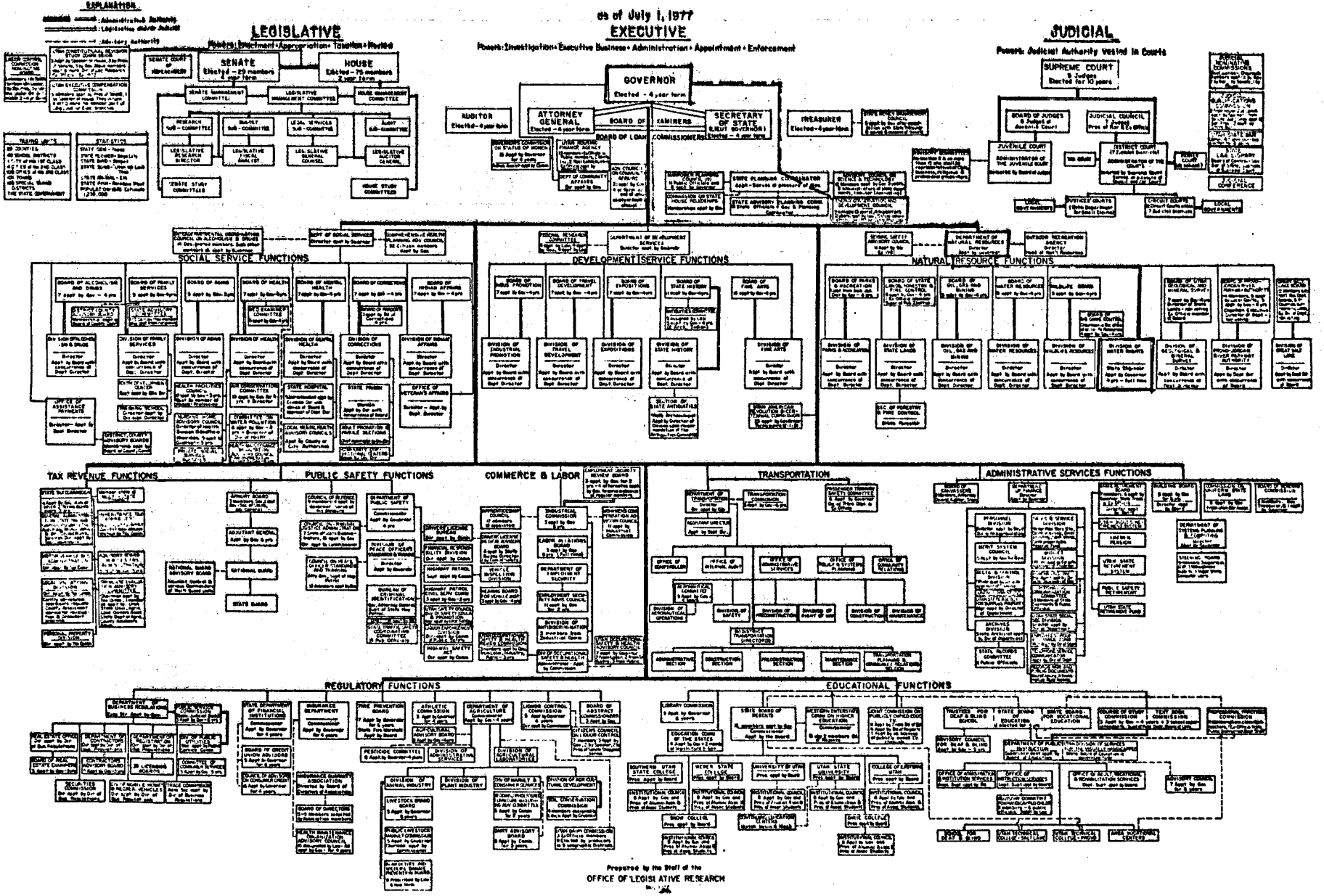
C-1 Diagram of Utah State Government

C-2 Diagram of Utah Division of Water Rights

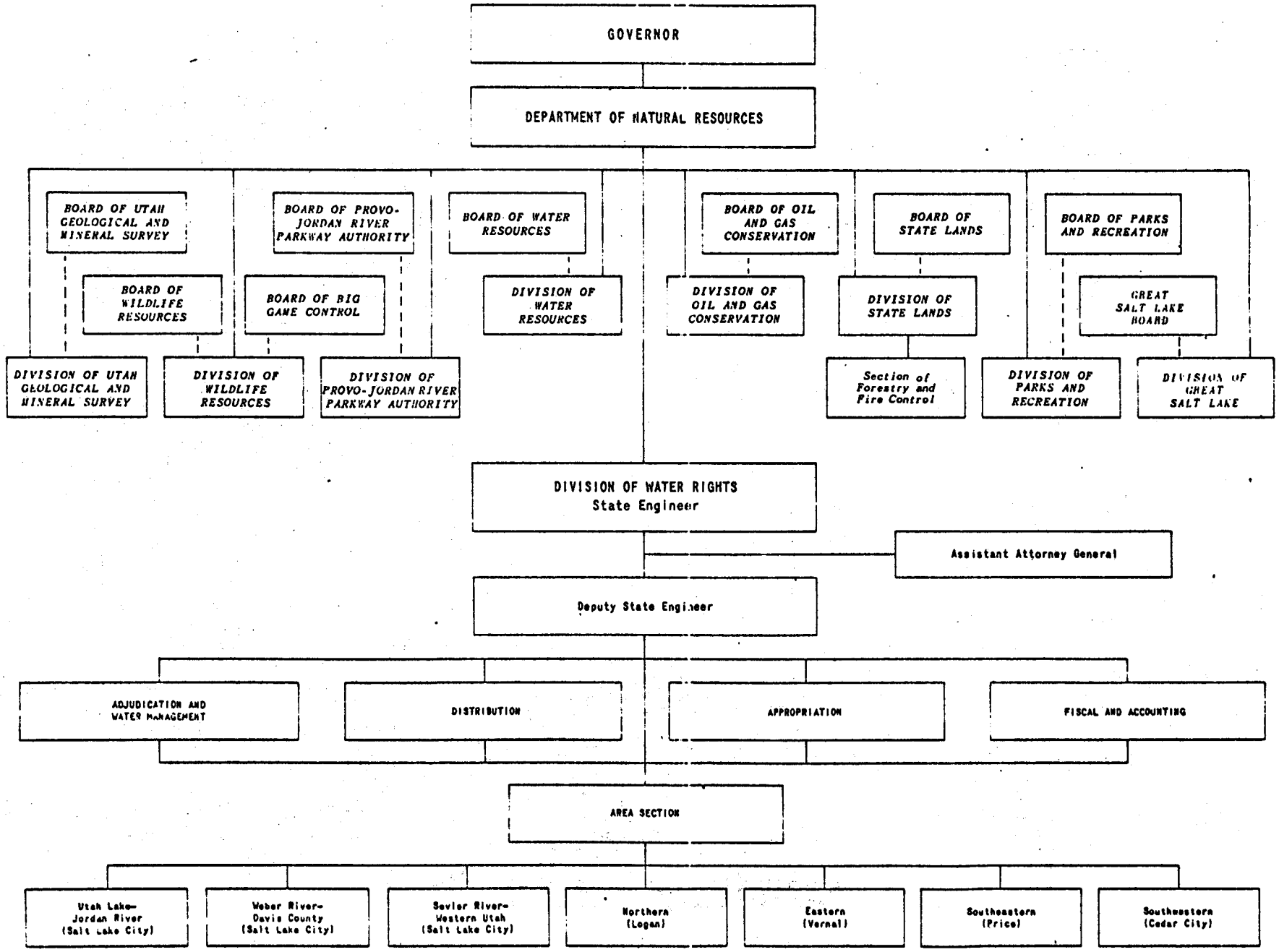
C-3 Procedural Flow Chart for the Utah Division of Water Rights

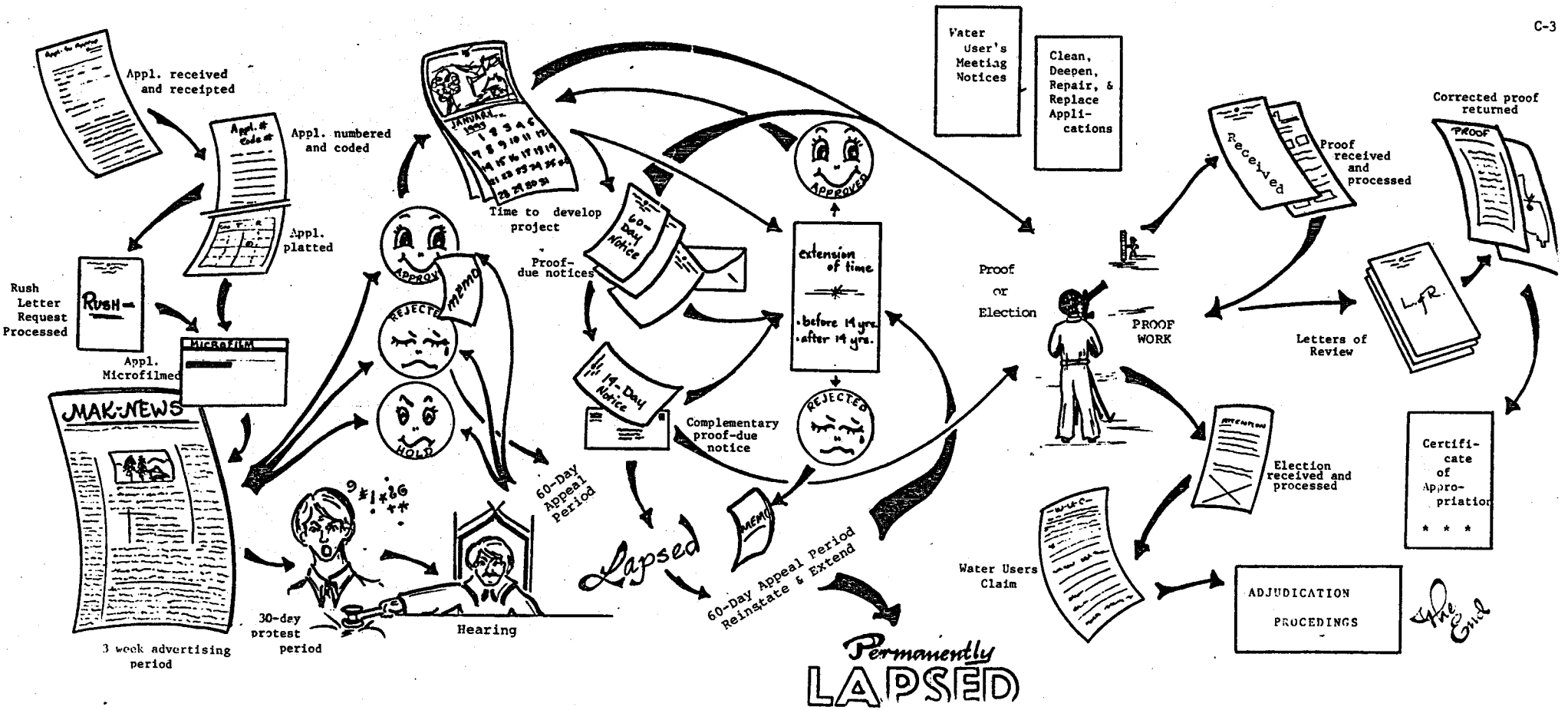
UTAH STATE GOVERNMENT

as of July 1, 1977



Prepared by the Staff of the
OFFICE OF LEGISLATIVE RESEARCH


GOVERNOR
DEPARTMENT OF NATURAL RESOURCES
BOARD OF UTAH GEOLOGICAL AND MINERAL SURVEY
BOARD OF WILDLIFE RESOURCES
BOARD OF PROVO-JORDAN RIVER PARKWAY AUTHORITY
BOARD OF BIG GAME CONTROL
BOARD OF WATER RESOURCES
DIVISION OF WATER RESOURCES
BOARD OF OIL AND GAS CONSERVATION
DIVISION OF OIL AND GAS CONSERVATION
BOARD OF STATE LANDS
DIVISION OF STATE LANDS
BOARD OF PARKS AND RECREATION
GREAT SALT LAKE BOARD
DIVISION OF UTAH GEOLOGICAL AND MINERAL SURVEY
DIVISION OF WILDLIFE RESOURCES
DIVISION OF PROVO-JORDAN RIVER PARKWAY AUTHORITY
Section of Forestry and Fire Control
DIVISION OF PARKS AND RECREATION
DIVISION OF GREAT SALT LAKE
DIVISION OF WATER RIGHTS
State Engineer
Assistant Attorney General
Deputy State Engineer
ADJUDICATION AND WATER MANAGEMENT
DISTRIBUTION
APPROPRIATION
FISCAL AND ACCOUNTING
AREA SECTION
Utah Lake-Jordan River (Salt Lake City)
Weber River-Davis County (Salt Lake City)
Sevier River-Western Utah (Salt Lake City)
Northern (Logan)
Eastern (Vernal)
Southeastern (Price)
Southwestern (Cedar City)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Appl. numbered and coded
Appl. platted
Rush Letter Request Processed
RUSH
Appl. Microfilmed
MICROFILM
MAK-NEWS
3 week advertising period
30-day protest period
Hearing
60-Day Appeal Period
Time to develop project
Proof-due notices
60-Day Notice
14-Day Notice
Complementary proof-due notice
extension of time
• before 14 yrs.
• after 14 yrs.
APPROVED
REJECTED
HOLD
MEMO
Lapsed
60-Day Appeal Period Reinstate & Extend
Permanently LAPSED
Water User's Meeting Notices
Clean, Deepen, Repair, & Replace Applications
Proof or Election
PROOF WORK
Proof received and processed
Corrected proof returned
Letters of Review
Election received and processed
Water Users Claim
ADJUDICATION PROCEDINGS
Certificate of Appropriation
The End

APPENDIX D

June 1978

PROGRAM AND OBJECTIVES OF THE INTERAGENCY GEOTHERMAL STREAMLINING TASK FORCE

The Interagency Geothermal Streamlining Task Force was formed to assist the Interagency Geothermal Coordinating Council (IGCC) in carrying out its mandate:

> "for assessing legal, environmental, regulatory, and other aspects of Federal, State, and local government policy as they relate to geothermal energy and for developing recommendations for changes and improvements in related laws, policies and procedures, and for examination of other institutional aspects of geothermal energy, including non-governmental aspects."

Specifically, the Task Force is developing recommendations to IGCC for appropriate action to implement the President's commitment to Congress that:

> "The Departments of the Interior and Agriculture will streamline leasing and environmental review procedures to remove unnecessary barriers to development of geothermal resources."

This objective was included in the President's comprehensive energy program submitted to Congress in April 1977. The commitment was prompted by the fact that although the Geothermal Steam Act was passed nearly seven and one-half years ago, there is still no commercial production of this resource on Federal lands.

There are many reasons for the lack of a viable geothermal industry -- such as the unknowns of the resource, the less-than-perfect technologies for utilizing and disposing of it, high-risk capital investment, and inequitable tax* and price structures. However, it is widely believed that the cumbersome Federal leasing and permitting program constitutes a major deterrent to timely development. As long as the inhibiting influence of the regulatory program clouds the rate of development on Federal lands, the effects of other impediments cannot be fully and accurately assessed.

The Geothermal Streamlining Task Force has undertaken a study which includes 1) a comprehensive analysis of the elements of the present

*New geothermal tax provisions are pending in a House/Senate conference committee and are described in a Comparative Committee Print entitled "Conference Comparison of the Energy Tax Provisions of H.R. 5263."

program designed to identify the sources of delay and quantify delays which are actually occurring; and 2) to determine the potential effects upon program performance of a series of options for program modification. The effectiveness of alternative options will be assessed in terms of their relative ability to support the Department of Energy's projected geothermal power-on-line schedule while adequately protecting the public interest and the environment.

The study will also incorporate input provided by the public, industry, environmental groups, and state agency officials through a series of workshops to be held in the western states in June. The schedule for these meetings is being finalized and is being widely publicized in order to obtain the broadest participation possible. The public meetings have been announced in the Federal Register.

The Task Force has developed a series of options for modifying the geothermal leasing and permitting program, described below, and comment on them will be requested from the above groups. In addition, suggestions for additional alternatives will be solicited.

The discussion of the options is preliminary and tentative and has not been reviewed by the attorneys of the Department of the Interior, the Department of Agriculture, or the Department of Energy. It is intended only to focus, for purposes of further discussion, on the problems which generated the suggestions for change and the remedial effects which may be exerted by the proposed options.

Option I

Improve the present system through changes in regulations and administrative procedures.

The Task Force is concentrating the largest bulk of its effort on Option I since improvements developed in the present system will almost certainly benefit the workability of any other option as well. This approach would maintain the basic features of the pre- and post-lease environmental reviews, but would increase the efficiency and uniformity of this major program function. Program modifications which will be considered include, but are not limited to, the following:

A. Use regional or areawide environmental analyses in pre-lease review and conduct site specific studies only during the post-lease permitting process.

The use of regional areawide analysis in the pre-lease situation would tend to reduce manpower/budget requirements and timeframe of performance. This approach would first permit more dependence on existing or in-progress Management Framework Plans of the Bureau of Land Management (BLM) or Land

Management Plans of the Forest Service (USFS), (which are discussed below under Option 2), or other resource-inventory type documents. This use of such documents is consistent with the new draft Council on Environmental Quality (CEQ) guidelines for implementing the National Environmental Policy Act (NEPA) (December 12, 1977) which encourage "integrating the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures, to the fullest extent possible, run concurrently, rather than consecutively." The draft guidelines would also require agencies to use "program, policy, or plan environmental statements and tiering from statements of broad scope to those of narrower scope to eliminate repetitive discussions of the same issues." While actual environmental statements per se are not necessarily at issue in this proposed program modification, it is felt that the language of this mandate is equally applicable to other types of environmental review documents.

In the absence of an existing plan, more generalized data gathering would still reduce time requirements and manpower utilization, freeing personnel for other work. Site specific studies at the post-lease stage would then identify the particular sensitivity of areas proposed for drilling, roads, and other permanent surface features.

Pending determination by the Solicitor of the Department of the Interior, this approach appears to be consistent with the BLM regulations on pre-leasing procedures. Section 3200.6, CFR Title 43, requires the Director, when an area is initially considered for geothermal leasing, to request reports from other interested agencies describing the resources contained "within the general area and the potential effect of geothermal resources operations upon the resources of the area and its total environment." (Emphasis added.)

The subsequent paragraph dealing with environmental impact evaluation, prior to final selection of tracts for leasing, calls for evaluation of the potential effects on the various resources of the entire area. There is no specifically stated requirement for site specific evaluation.

History shows that less than 1 out of 25 lease applications may be expected to result in any surface disturbing operations. Thus, the low intensity pre-lease broad based assessment proposed in this approach would be appropriate to the majority of lease application areas. Detailed site specific environmental analyses would be done on the relatively few leases that would undergo surface disturbing exploration or development as a prelude to actual operation.

The major advantages of utilizing fewer environmental analyses of broader scope are:

- Less overlapping and redundancy and thus lessened manpower, time, and dollar requirements.

- Lower printing and publications costs

This approach is used by BLM in Nevada on geothermal lease applications and USFS oil and gas leasing in North Dakota on the Little Missouri Grasslands. Estimated time and dollar savings are at least 60% when compared to the "piece mealing" methods used in other areas such as BLM California and USGS Washington-Oregon.

This option is in accord with current U.S. Forest Service policy under the National Forest Management Act. A policy decision on the part of other agencies would be required.

B. Set time limits or timeframes (through administrative directive and/or regulations) for issuance of leases and permits.

The draft CEQ guidelines for implementing NEPA note that while the Council considers universal time limits for the entire NEPA process too inflexible, it encourages all Federal agencies to "set limits if an applicant for the proposed action requests them, provided they are consistent with the purposes of NEPA and other essential considerations of national policy."

The only action in the geothermal pre- and post-lease approval process which is subject to a time constraint under the existing regulations is the Notice of Intent (NOI) to conduct exploration operations which the authorized officer is directed to approve or disapprove within 30 calendar days. This offers precedent for imposition of time limitations on other actions in the process.

A major advantage of this approach is that adherence to a realistic mandated schedule determined according to the criteria set forth in the draft CEQ guidelines would serve to generally reduce the length of time required for each action in the leasing and permitting process, although a precise estimate of time savings cannot be made at this time. It is felt, however, that when faced with realistic deadlines the backlogging of applications would diminish. Another advantage is that the approach would provide for more uniformity in processing schedules, an occurrence which would enhance more efficient developer planning. Failure to meet the scheduled timeframe would require a report of accountability to the applicant. In summary, this approach makes the process timing sensitive and visible.

A disadvantage is that the approach would require increased budgets and manpower in some BLM/FS field offices and in the responsible GS office.

On the other hand, it would at the same time provide a more concrete basis for projecting budget/manpower needs than the present system which tends to function, at lease in some office, in response to available resources rather than to needed resources. In other words, this program modification would provide a mechanism for establishing firm priorities.

C. Improve coordination in all phases of pre- and post-lease activities.

Since the geothermal program is jointly implemented by BLM, USFS, and U.S. Geological Survey (USGS) with still another review element in the Fish and Wildlife Service (FWS), there is significant opportunity for process delay in routine steps such as repetitive notifications, approvals, signatures, and transmittals. Improving the coordination between these agencies for the purpose of expediting the leasing and post-lease programs is consistent with the similar objective established for the Geothermal Energy Coordination and Management Project in the related area of geothermal research, development, and demonstration. The Project is composed of members from a number of involved departments and agencies, including the Departments of the Interior and Agriculture. P.L. 93-410, the Geothermal Energy Research, Development and Demonstration Act of 1974 and P.L. 95-238, Department of Energy Act of 1978 -- Civilian Applications, give to the Project the overall responsibility for the provision of effective management and coordination with respect to the Nation's geothermal research, development, and demonstration (RD&D) program.

The Project is directed to "make such recommendations for legislation or administrative regulations as may from time to time appear to be necessary to make Federal leasing, environmental, and taxing policy for geothermal resources consistent with known inventories of various resource types, with the current state of technologies for geothermal energy development, and with current evaluations of the environmental impacts of such development, and with current evaluations of the environmental impacts of such development." While the streamlining goal of the Task Force does not fall under the RD&D program umbrella per se, consistency in coordination in the regulatory program is warranted. There appear to be several methods for accomplishing this goal.

One is to establish in each agency field level coordinators for the geothermal program. A previous related study found that developers in general feel that program performance improves as the process becomes more localized -- i.e., that their needs are better attended by responsible personnel on the scene who are already intimately familiar with the locale, its resources, and problem areas. This situation would be further enhanced by the presence of personnel of all responsible agencies with geothermal activities as their primary program concern who could interact locally.

The need for such personnel is especially apparent at the regional level in some regions of the USFS, and a multi-regional coordinator located

at the center of activity is badly needed. It would be desirable that USFS and BLM coordinators be housed at the same location (Boise appears most logical) so as to facilitate communications.

Another potential approach to improved coordination is to consider modifying the existing Memorandum of Understanding (MOU) so as to establish guidelines for interagency cooperation among the Departments of Energy, Interior, and Agriculture in implementing the geothermal program. The MOU is the basis for the large bulk of the steps shown in Figures 1 and 2 which indicate the numerous opportunities for process slippage. Forest Service activities, which are not included in the MOU and are not shown in Figures 1 and 2 add other comment, approval, and transmittal steps to the process when forest lands are involved in KGRA lease sales and non-competitive lease applications.

Specific steps should be taken by the Departments to identify time limits for communication between their agencies. For example, KGRA clearlisting should require no more than 10 working days, and responses on approval of a Plan of Operation should also reach USGS within a similar timeframe.

The groups within the agencies charged with the writing of regulations and directives for the geothermal program should be adequately staffed and funded so that badly needed minerals program management may be carried out in a timely fashion. The need for a higher priority in manpower funding is exemplified by the fact that the geothermal power plant siting regulations were 2 years in preparation. With adequate manpower, such regulations could be proposed within 6 months.

D. Improve uniformity and consistency of policies and procedures with respect to lease stipulations among the involved agencies.

Two separate steps appear to offer the best potential for optimum improvement through this route. The first is to establish uniform policy and guidelines for special lease stipulations. In current practice, the surface management agencies sometimes attach stipulations which are unacceptable to the USGS Area Geothermal Supervisor's office and considerable time may be lost in negotiating the final stipulations. Uniform policy agreed to in advance by the involved agencies could reduce the frequency of this source of delay and alleviate to some extent developer uncertainty on special stipulations.

Another means of increasing interagency efficiency is to standardize special lease stipulations of similar nature and intent -- i.e., archaeological, endangered species, etc. The reasoning here is that past experience indicates some "one-upmanship" or pride of authorship in writing stipulations which creates unnecessary confusion and requires legal review of word changes. Not only should this delaying situation be avoided but the standardized stipulations should be expressed in

language immediately comprehensible to all levels of government and industry personnel who must be concerned with them. The potential for delay in erroneous interpretation or time wasted in seeking the correct interpretation is readily evident.

Revision of the geothermal lease form to incorporate standardized stipulations appears to be the best method for implementing this change which would avoid repetitive legal review of word changes. At the same time the lease form could be combined with the application form (as is now the case in oil and gas leases) which would save an estimated 30 days per application and eliminate one form.

No disadvantages in this approach are foreseen. Its implementation would require 2 man months and no changes in regulations or policy.

E. Institute formal nomination procedures for KGRA's and non-competitive areas.

The BLM regulations provide for receipt of nominations, or public expressions of interest in leasing certain described areas, either on an individual voluntary basis or upon the Secretary's call for nominations to lease. This provision has never been implemented, however, in that BLM has neither prepared an approved form (43 CFR, 3220.2) for receiving nominations nor issued calls for nominations (3220.1). It has instead treated non-competitive lease applications as nominations and has entertained requests for lease sales through letter correspondence or oral communication.

A formal nomination procedure would probably not have substantial effect on non-competitive areas, but an advantage could possibly accrue if such a procedure were used to identify, on the basis of expressed industry interest, the priority areas for completion of baseline studies needed to expedite competitive lease or no-lease decisions and in turn guide the location of competitive lease sales. A common industry justification for lack of development is that much of the land it considers most promising is not available under the present system. If this assertion is valid, development would be expedited by prioritizing activity in the areas which industry's nominations indicate are most likely to be developed if the acreage is made available.

In past experience, the less environmentally-sensitive prospect areas, and therefore the easiest to study, have often been investigated first only to generate little or no interest in the subsequent lease sale. In those instances, the effort would have been more productive if it had been applied to the more promising areas.

The success of this program change would hinge on industry's willingness to submit nominations and on amendment of the existing procedures for

classifying land as KGRA's. Developers have previously stated their reluctance to nominate acreage because of their fear that nominations would result in an increase in KGRA designation.

Potential advantages of this proposal would be to focus agency attention on competitive areas industry feels most desirable and to effect a minor time savings in developing planning priorities. Costs of this proposal would be negligible, and since some benefit might accrue, it is recommended that the involved agencies attempt to solicit nominations for planning purposes.

F. Allow no-surface-occupancy leases in wilderness study areas and other special areas where requested.

Some benefits would be gained from issuance of no-surface-occupancy leases in areas of mixed land ownership (areas composed of intermingled tracts of federal, private, and state lands), or in wilderness study or other special areas where leases on the federal lands cannot be issued.

If no leases are issued on the Federal portions pending the outcome of the study, any operator proceeding to discovery on adjacent or nearby non-Federal land risks facing a KGRA designation of the Federal tracts (43 CFR 3200.0-5k(2)). He would then be faced with competitive bidding as his only access to desired tracts in the Federal acreage if the land is not locked into no-lease status. In view of the fact that his own discovery would tend to attract other serious bidders, he risks losing to competitors those lands which are primarily valuable because of his own discovery.

A no-surface-occupancy lease could benefit him in two ways. First, it would protect his competitive interest throughout the study and decision-making period and, second, depending on engineering and economic feasibility, make recovery of the resource from this type of lease achievable through directional drilling. Certain types of non-surface disturbing activities would be allowed as appropriate on the particular lands under this type of lease.

The potential disadvantage of this approach to industry is that the lessee takes the risk of being unable to develop the lands that he has leased. Thus, there is potential for future litigation if a discovery is made. In addition, supervision of the lease by surface management agencies would be required which would not be necessary if the land were not leased. The additional costs and workload appear minimal, however, and the proposal is consistent with current law and regulation.

G. Modify KGRA regulations.

KGRA's are classified by geologic criteria and also by "competitive interest" (43 CFR 3200.0-5(k)(3)), caused by overlapping of applications filed within the same period. Lands in either type of KGRA can only be leased through competitive bidding. A recent study of all geothermal leases issued shows that the pace of competitive leasing is far behind that of non-competitive. The most recent summary shows that 1081 non-competitive leases have been issued on over 1.85 million acres of land, as compared to 239 competitive leases on 339,000 acres. Bids received number less than half the tracts offered, and about 30 percent of the sales have produced no bids at all. The total number of tracts of interest was even less than the number of bids received since multiple bids were made on the same tracts in some cases.

The reasons for this situation are not clear at present. They may reflect developer contention that the desirable tracts are not being offered, as discussed above, or the cost of competitive leases vs. non-competitive may be an inhibiting factor. The numbers do indicate, however, that the existence of KGRA's, which by definition should be more desirable than non-KGRA lands, are impeding the pace of leasing. Thus, the potential effect of amendments to the BLM regulations (43 CFR, 3200.0-5(k)) to change KGRA criteria is being investigated.

Three approaches are under consideration. They include:

- Reclassification of geologic KGRA's and competitive interest areas after they have been through unsuccessful lease sales.
- Abolish the competitve interest regulations (43 CFR, 32.00.0-5(k)(3)). The competitive interest concept is an impediment to an orderly non-competitve leasing program, and has caused delay in leasing with little financial return to the government.
- Provide for direct thermal utilization areas, to encourage use of low temperature geothermal waters.

There are several rationales for separate treatment of direct thermal utilization, or non-electric use of the resource, as opposed to electric power production. First, the requirements of the resource itself are different -- temperature, pressure, and reservoir size requirements are less demanding for most direct uses than for power generation although in some cases a purer resource is required -- and the type and degree of environmental impact will vary with the use. In general, the potential impacts from power production or industrial use may be expected to be more severe than those associated with domestic or agricultural use.

In addition, many if not most municipalities would be precluded, by their charters or financial responsibility requirements, from bidding on competitively-offered tracts. Thus, the most likely users of direct heating systems could not gain access to the resource on a KGRA, which in some instances might be designated because of a municipality discovery on adjacent or near-by state or private lands.

Since some of the geologic KGRA's and competitive interest areas draw no bids on being offered several times, it appears that revision of the criteria for classification in the regulations is needed -- i.e., the current KGRA standards may or may not be realistic in the light of present knowledge.

Reclassification of KGRA's and competitive interest areas lies under the authority of USGS and its area geologists. To date, no KGRA or competitive interest area has ever been reclassified.

Advantages of modifying the KGRA regulations would be more orderly development and more efficient use of the resource. Time would be saved in that leases could come on line more rapidly. No disadvantages are recognized, and costs and impacts upon manpower would be minimal.

H. Allow issuance of non-competitive leases unless the area is in a KGRA at time of application.

In present practice, non-competitive leases are not issued if the acreage involved is in a designated KGRA when the adjudication process is completed, and the applicant has signed the lease form. The KGRA clear list report is the last step in the procedure before the lease is issued, and the lease may be rejected at this late point on the basis of the clear list report. When this happens, the adjudicatory effort has been wasted. If the above change were effected, a change in KGRA status during the adjudicatory process would not affect issuance of the lease.

This approach would alleviate applicant uncertainty as to possible classification of lands during the adjudication process, and would allow applicants to commence exploration on adjacent non-Federal lands without risk of having the applied-for lands classified as a KGRA as a result of his work. Elimination of the clear list report would also speed up lease issuance.

The disadvantages of the approach include a potential loss of revenue due to loss of bonus-bids and decreased rentals, and the fact that legal modification and changes in regulations may be required. No staffing or direct budget impact are seen.

I. Provide budgets in proportion to workloads, organizational needs, and priorities.

The new draft regulations to implement NEPA require all agencies to "have sufficient capability, including personnel and other resources," to comply with Section 102 of the Act and Executive Order 11514, Protection and Enhancement of Environmental Quality. The geothermal programs of the involved agency field offices have commonly been short of this goal in their share of overall budgets.

Specifically, the pace of environmental assessment preparation and the various types of land management planning has been impeded by the inadequate budgets, and it is felt that a budgetary remedy must be a primary focus of any streamlining effort. The minerals management effort has historically been underfinanced and understaffed.

Option II

Base leasing decisions on areawide environmental assessment in combination with land management plan.

This option is based primarily on the existence of the planning requirements imposed by the Federal Land Policy and Management Act of 1976 (P.L. 94-759) and the National Forest Management Act of 1976 (P.L. 94-588) on BLM and the Forest Service, respectively.

The former requires BLM to prepare and maintain on a continuing basis an inventory of all public lands and their resource and other values, giving priority to areas of critical environmental concern. Just such a priority has been needed in the geothermal program, as discussed above, so that lease or no-lease decisions can be made on this type of area which includes geothermal among its resources. The inventory itself does not preclude leasing since the Act states that: "The preparation and maintenance of such inventory or the identification of such areas shall not, of itself, change or prevent change of the management or use of public lands." (Section 201(a)). The use of public lands is covered by a further requirement for formulation of plans "which provide by tracts or areas for the use of the public lands." These plans are to cover all public lands regardless of whether such lands have been previously classified, withdrawn, set aside, or otherwise designated for one or more uses. (Section 202(a)). No completion date is mandated for these plans.

The National Forest Management Act directs the Secretary of Agriculture to incorporate the standards and guidelines provided by the Act for National Forest System Resource Planning (Section 6) into plans for units of the system" as soon as practicable after enactment..." and to "attempt to complete such incorporation for all such units by no later than

September 30, 1985." Until such time as a unit is subject to a plan developed in accordance with the Act, its management may continue under existing land and resource management plans.

The various plans completed under this relatively new legislation, or previously, will provide "on-the-shelf" information for application in planning competitive geothermal lease sales and in processing non-competitve lease applications. Such information is necessary, it is believed, before the geothermal program can move on with sufficient speed for prudent development and with appropriate environmental safeguards.

Where the land management plans have been completed, Option 2 is actually in effect. Many of the forest management plans are completed or near completion and all National Forest Plans are to be completed by 1983, and will be fully operational under this system by 1985. In Nevada, where an initial land plan has been completed for most areas by BLM, leasing has proceeded very rapidly. Where land management plans are not complete, or where the existing plan does not consider geothermal energy production and utilization, two alternatives are available:

- Completing or amending the land management plan to consider geothermal development with environmental assessment as appropriate.

- Designing an environmental assessment specifically for incorporation into the management plan at the next revision. This process would recognize the existing plan's limitations while providing supplementary information which could fulfill needs on a limited area for immediate leasing decisions. The area to be considered would be the area which might reasonably be assumed to be affected prior to scheduled revision of the plan.

The comprehensive nature of the data gathering done in construction of the land management plan will reduce the pre-lease and post-lease data gathering and environmental review requirements considerably.

The advantage of this option is that it makes full use of the land management plans as they are now being developed, and makes allowance for the consideration of all resources and uses in their proper perspective on the lands in question. With an adequate land management plan, the additional environmental analysis needed to implement any action on those lands can be done very rapidly and cheaply. In the overall picture, this method is more effective with respect to manpower and dollars.

The disadvantage is that initially this process would require longer front end delay.

Option III

Provide for separate environmental analysis of exploration and development phases, with initial review of exploratory impacts only and comprehensive review only after a discovery is made.

At present, most pre-lease environmental analyses assume the "worst-case" level of potential impact -- that of full scale development for power generation. However, the potential impact of the exploratory phase alone is minor compared to full development, and on a large majority of leases activity will cease with exploration and restoration of the site because no exploitable resource will be found.

Thus, it is felt that efficiency in time and manpower utilization can be achieved, and the environment adequately protected, by applying the environmental review in the pre-lease period to exploration alone. One proposed method of implementing this policy would be through issuing leases granting full rights for the exploration and testing phases, but conditional rights only to commercial development contingent upon further detailed environmental analysis. It is believed that development rights could be held in abeyance in the lease through the use of special lease stipulations.

This approach stems from recent consideration of issuing oil and gas leases in potential wilderness ("roadless") areas. At an April 18, 1978, meeting in Denver attended by representatives of the Department of the Interior and industry, it was proposed by the Department that leases be issued with the restriction, via a special lease stipulation, that exploratory wells only could be drilled, with production and full-scale development contingent upon whether the acreage is eventually excluded from the Wilderness System. The important concept here is that a "two-stage" lease is contemplated to be legally accomplished with a special stipulation in the lease and no change in existing law.

If the concept proves workable, it should likewise prove applicable for any geothermal leasing situation where separation of the two phases would be advantageous. Pending further review, the basic approach appears feasible without amending the Geothermal Steam Act although 43 CFR 3200.0-6 may require modification to make this option feasible.

In addition, in order to permit the lessee to identify the resource and determine whether it is commercially exploitable, the two-stage concept envisions redefining "exploration operations" to include the drilling and testing of one or more deep wells. If an exploitable discovery were made, the special stipulation for development would not be removed until a comprehensive environmental review, considering the nature of the resource and the plans of the lessee indicated the suitability of the area for development.

In addition to achieving efficiency and providing adequate environmental protection, any version of Option 3 adopted must also consider the lessee's right to develop -- i.e., such a program must be implemented in a manner which will encourage development. Present thinking envisions this option as an elective choice approach, with a one-stage lease still available to developers if they prefer the existing system.

This option would reduce time spent in pre-lease, environmental assessment, and would require no more time for post-lease analysis than at present since these post-lease analyses are being done in sufficient detail now. The biggest time saving might occur in sensitive areas although these areas represent the greatest chance for denial or limitation of development.

The major advantage which would accrue to the lessee is that after discovery and testing, the extent and potential value of the resource is much better known, and positively located in relation to surface values, making management trade-off value analysis much more knowledgeable and easier -- i.e., both the surface and subsurface values are now known.

The principal disadvantages to the lessee include the potential for unreasonable denial of development and the adverse economics of being unable to develop a commercially viable resource.

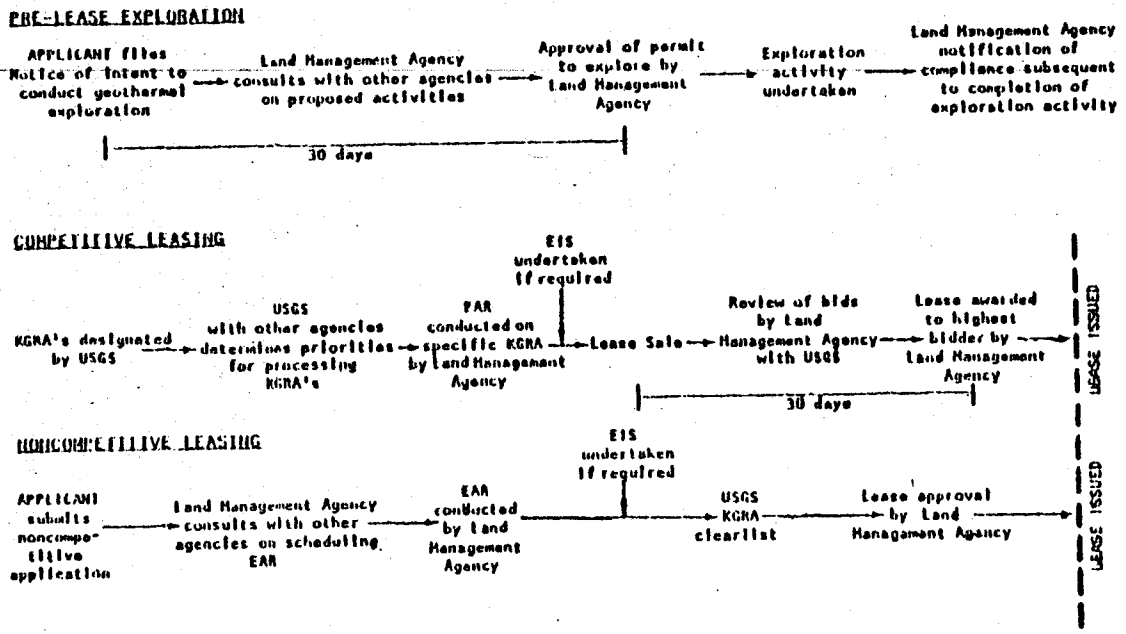
Written comments should be addressed to:

Winston B. Short
Chairman
Geothermal Streamlining Task Force
Interior Building
19th & E. Streets
Washington, D.C. 20240

EXISTING

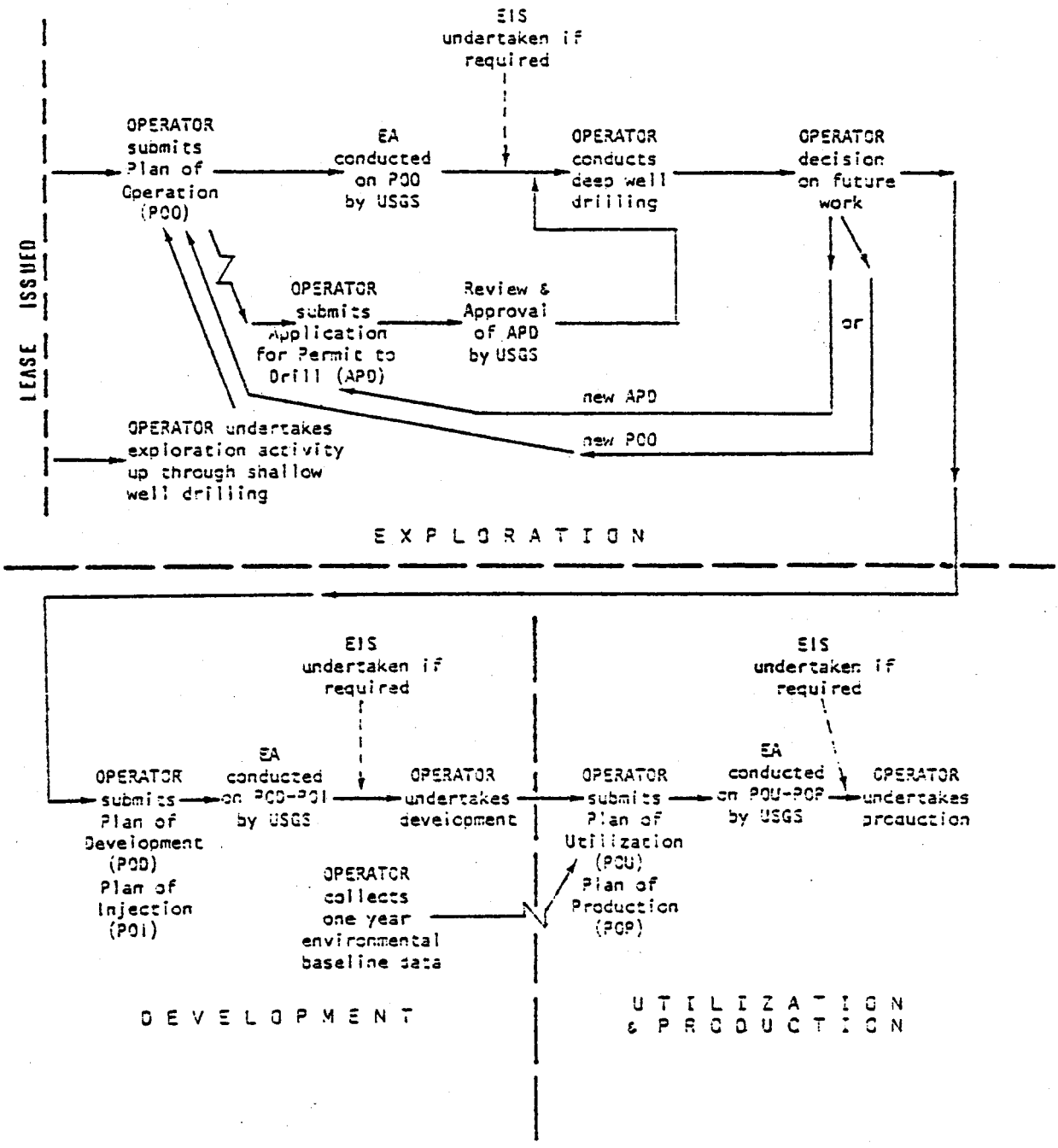
GEOTHERMAL REGULATORY PROCESS

Principal Pre-Lease Activities



EXISTING

GEOTHERMAL REGULATORY PROCESS
Principal Post-Lease Activities



Sample Leasing EAR Schedule

Field Inventory – Data Analysis	6 Months
Drafting and Internal Review	5 Months
State Office Review	2 Months
Public Review	3 Months
Publication	1 Month
	17 Months

Expected Annual Federal Regulatory Workload
(Preliminary)

(Moderate Growth Scenario)

	1977	1980	1985	1990
Leases	200	200	300	600
Well Permits	100 (20)	75	400	1,000
Power Plants	2	5	30	150

ENVIRONMENTAL REVIEW

PATH OF FEDERAL GEOTHERMAL PROGRAM

Environmental Reviews	Impacts Considered
Programmatic EIS - BLM	Exploration - Development (Generic)
Land Management Plan - BLM - FS	Exploration - Development (Area-Wide)
Pre-Lease EAR - BLM - FS	Exploration - Development (Area-Wide)
Plans of Operation - USGS	Phased - Site - Specific
Exploration (Initial)	
Exploration (Subsequent)	
Development	
Injection	
Utilization	
Siting License (BLM)	
Permit to Construct and Operate	
Production	Site - Specific

STATUS OF LEASE SALES ON KGRA'S

State	Total Federal Acreage		Theoretically Available For Leasing		Acres Offered		Acres Bid On		Acres Accepted		Federal Acres Remaining for Lease	
	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS	BLM	FS
Ariz.	3,240	0	3,240	0	780	0	0	0	0	0	3,240	0
Calif.	387,374	394,582	353,054	394,582	90,167	0	40,235	0	39,449	0	313,605	394,582
Colo.	19,045	1,780	11,271	1,513	11,271	0	5,036	0	5,036	0	6,235	1,513
Idaho	103,500	42,500	52,500	40,500	48,500	0	32,000	0	32,000	0	20,500	40,500
Mont.	8,861	29,170	8,861	29,170	320	1,280	0	0	0	0	8,861	29,170
Nev.	326,802	4,160	326,802	4,160	201,988	2,560	148,163	0	145,682	0	181,120	4,160
N. Mex.	190,320	1,316,004	190,320	1,224,004	101,693	29,375	62,482	18,050	62 48[illegible]	18,050	127,838	1,205,954
Oregon	198,495	62,125	198,495	61,605	155,910	0	68,873	0	63,911	0	129,210	61,605
Utah	83,215	15,572	83,215	15,572	78,966	10,852	77,277	10,852	77,277	10,852	7,138	4,719
Wash.	0	19,001	0	13,187	0	0	0	0	0	0	0	13,187
Wyo.	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	1,320,852	1,884,894	1,227,758	1,784,293	689,595	44,067	434,066	28,902	425,837	28,902	797,747	1,755,390

BLM NONCOMPETITIVE GEOTHERMAL LEASING
AS OF DECEMBER 31, 1977

	NO. OF APPLICATIONS	NUMBER ISSUED	NUMBER PENDING
ARIZONA	57	4	17
CALIFORNIA	674	10	260
COLORADO	86	43	7
IDAHO	564	111	164
MONTANA	33	6	1
NEVADA	1399	409	129
NEW MEXICO	574	85	146
OREGON	657	102	189
UTAH	497	208	57
WASHINGTON	0	0	42
WYOMING	19	0	56
EASTERN STATES	0	0	0
TOTALS	4560	978	1068

JUNE 1978

CHRONOLOGICAL MILESTONES IN THE FEDERAL GEOTHERMAL LEASING AND PERMITTING PROCESS

- GEOTHERMAL STEAM ACT (P.L. 91-581) PASSED 12/24/70
- IMPLEMENTING BUREAU OF LAND MANAGEMENT AND U.S. GEOLOGICAL SURVEY REGULATIONS BECAME EFFECTIVE 1/1/74 (43 CFR, GROUP 3200 AND 30 CFR, PARTS 270 AND 271)
- GENERIC ENVIRONMENTAL IMPACT STATEMENT COMPLETED 10/73
- FIRST ENVIRONMENTAL ANALYSIS RECORD COMPLETED, SURPRISE & WARNER VALLEY, CA TRANSMITTAL TO STATE OFFICE 1/24/75
- FIRST NON-COMPETITIVE APPLICATIONS FILED 1/74
- FIRST LEASE SALE HELD 1/22/74 (CA)
- FIRST NON-COMPETITIVE LEASE ISSUED 1/16/75 (NV)
- FIRST ENVIRONMENTAL ANALYSIS COMPLETED 8/26/74 (USGS, CA, GEYSERS)
- FIRST PLAN OF OPERATION (EXPLORATION) APPROVED 9/6/74
- FIRST DRILLING PERMIT ISSUED 9/9/74
- FIRST PLAN OF OPERATION (DEVELOPMENT) RECEIVED 10/18/77 (REPUBLIC EAST MESA)
- FIRST PLAN OF OPERATION (INJECTION) RECEIVED 10/28/77 (REPUBLIC EAST MESA)
- FIRST PLAN OF OPERATION (UTILIZATION) RECEIVED 6/23/77 (MAGMA EAST MESA)
- FIRST PLAN OF OPERATION (PRODUCTION) EXPECTED 9/78

FOREST SERVICE NON-COMPETITIVE GEOTHERMAL LEASING AS OF DECEMBER 31, 1977

	NO. OF APPLICATIONS	NUMBER ISSUED	NUMBER PENDING
ARIZONA	67	1	55
CALIFORNIA	397	0	169
COLORADO	73	0	34
IDAHO	317	1	208
MONTANA	55	0	11
NEVADA	13	3	15
NEW MEXICO	42	0	27
OREGON	378	3	218
UTAH	106	10	35
WASHINGTON	277	0	100
WYOMING	121	4	19
EASTERN STATES	12	11	0
TOTALS	1858	33	891

JUNE 1978

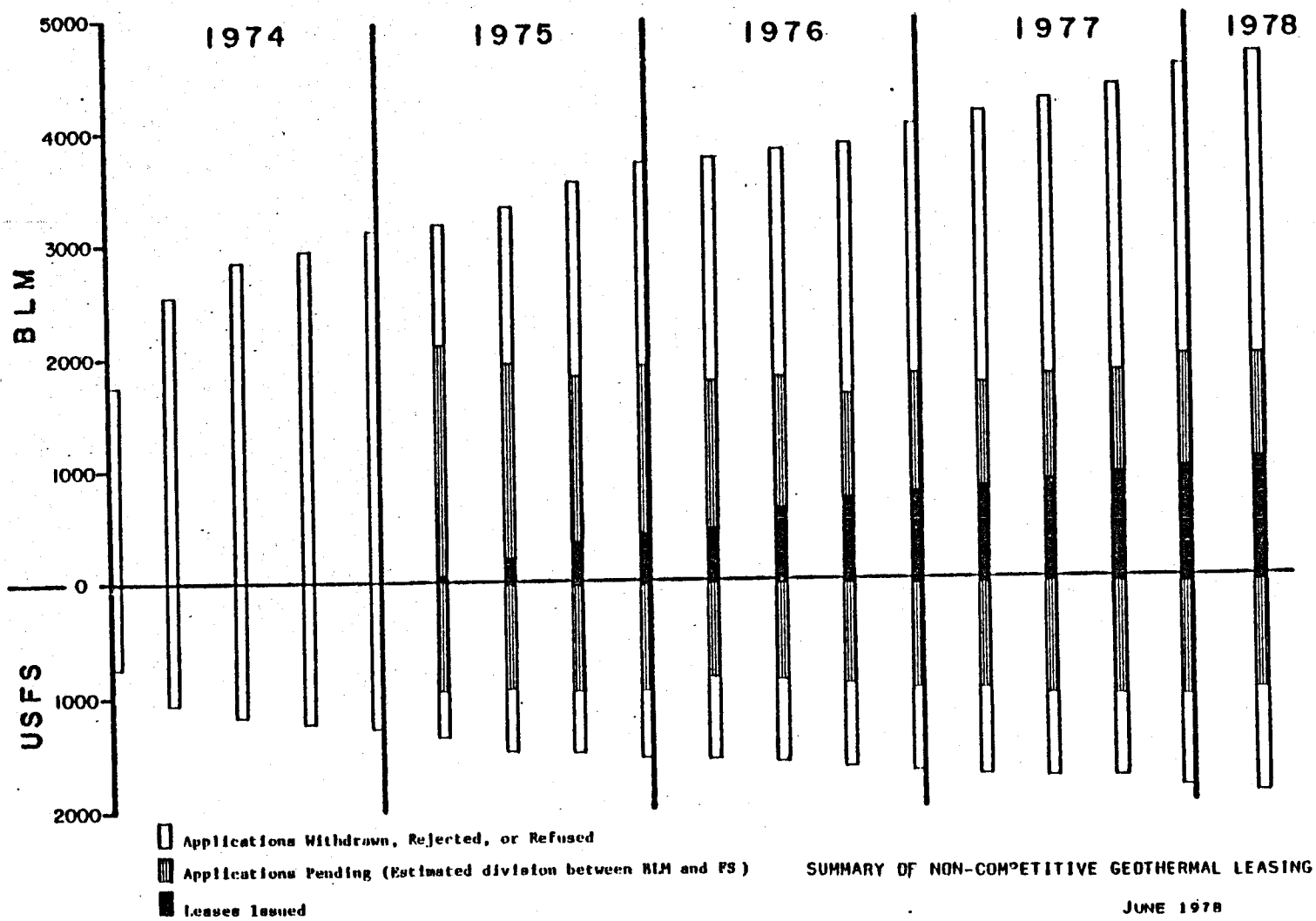
CUMULATIVE

SUMMARY OF NON-COMPETITIVE GEOTHERMAL LEASING

(BY QUARTER FROM 1974 TO PRESENT)

JUNE 1978

		BUREAU OF LAND MANAGEMENT				FOREST SERVICE			
	MONTH	TOTAL APPLS.	APPLS. WITHDRAWN, REJECTED OR REFUSED	APPLS. PENDING	LEASES ISSUED	TOTAL APPLS.	APPLS. WITHDRAWN, REJECTED OR REFUSED	APPLS. PENDING	LEASES ISSUED
	1	1744				712			
	3	2542				1038			
1974	6	2870				1172			
	9	2965				1211			
	12	3117				1273			
	3	3188	1077	2087	24	1359	420	939	0
1975	6	3334	1394	1720	220	1430	505	925	1
	9	3560	1722	1462	376	1467	520	942	5
	12	3711	1794	1491	426	1526	569	943	14
	3	3766	1979	1339	448	1552	706	831	15
1976	6	3827	2022	1164	641	1596	733	848	15
	9	3880	2231	924	725	1640	740	885	15
	12	4066	2259	1021	786	1684	740	925	19
	3	4163	2418	933	812	1715	744	952	19
1977	6	4290	2487	918	885	1753	745	989	19
	9	4395	2575	881	939	1765	746	988	31
	12	4560	2580	1002	978	1858	813	1012	33
1978	3	4649	2685	924	1040	1882	885	956	41

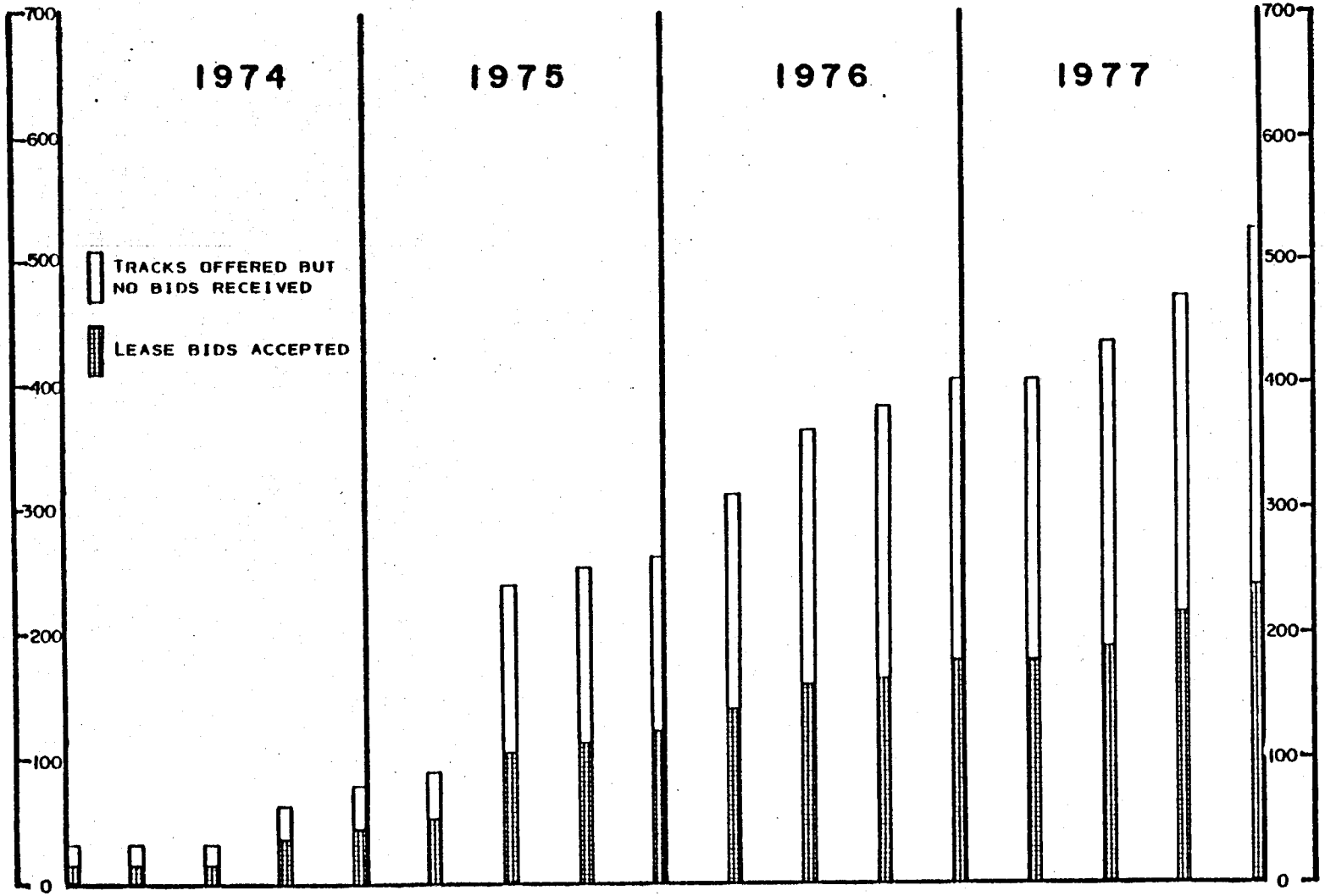


SUMMARY OF NON-COMPETITIVE GEOTHERMAL LEASING

JUNE 1978

AGE OF NON-COMPETITIVE LEASE APPLICATIONS STILL PENDING (as of 4/78)

State	5 mo. or less		6-11 mos.		12-17 mos.		18-23 mos.		24-35 mos.		36 mos. or more		Totals	
	BLM	USFS	BLM	USFS	BLM	USFS	BLM	USFS	BLM	USFS	BLM	USFS	BLM	USFS
Ariz.	3	0	2	27	11	0	0	0	2	26	7	1	25	54
Colo.	0	0	0	0	0	0	0	0	0	0	9	27	9	27
Calif.	11	10	16	17	42	0	9	3	27	18	177	123	282	171
Idaho	44	1	46	17	1	0	9	1	27	52	62	143	189	214
Mont.	0	0	0	0	0	0	0	0	0	0	2	12	2	12
Nev.	35	1	18	0	3	0	4	0	17	1	197	8	274	10
N. Mex.	23	6	11	5	24	0	0	0	8	3	144	28	210	42
Oreg.	10	17	10	7	13	25	10	17	40	28	144	424	227	518
Utah	16	1	22	1	23	9	11	6	9	3	135	41	216	61
Wash.	0	20	0	0	0	0	0	0	8	16	0	3	8	39
Total	142	56	125	74	117	34	43	27	138	147	877	810	1442	1148



SUMMARY OF COMPETITIVE GEOTHERMAL LEASING

(BY QUARTER FROM 1974 TO PRESENT)

JUNE 1978

CUMULATIVE
SUMMARY OF COMPETITIVE GEOTHERMAL LEASING

	Month	Total Tracts Offered	Tracts Offered But No Bids Received	Lease Bids Accepted
1974	1	33	15	18
	3	33	15	18
	6	33	15	18
	9	65	27	38
	12	80	33	47
1975	3	91	35	56
	6	240	132	108
	9	253	138	115
	12	262	139	123
1976	3	313	171	142
	6	365	204	161
	9	382	215	167
	12	405	226	179
1977	3	406	227	179
	6	434	243	191
	9	471	253	218
	12	523	284	239

JUNE 1978

SUMMARY OF ENVIRONMENTAL AND CONSERVATION LAWS IMPACTING THE FEDERAL GEOTHERMAL LEASING AND PERMITTING PROGRAM

GEOTHERMAL STEAM ACT OF 1970

NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

FEDERAL LAND POLICY AND MANAGEMENT ACT OF 1976

NATIONAL FOREST MANAGEMENT ACT OF 1976

FISH AND WILDLIFE COORDINATION ACT

ENDANGERED SPECIES ACT OF 1973

NATIONAL HISTORIC PRESERVATION ACT OF 1966

FEDERAL WATER POLLUTION CONTROL ACT, AS AMENDED

CLEAN AIR ACT, AS AMENDED

RESOURCES CONSERVATION AND RECOVERY ACT

NOISE CONTROL ACT OF 1972

COASTAL ZONE MANAGEMENT ACT OF 1972

WILD AND SCENIC RIVERS MANAGEMENT ACT

OTHER CONSERVATION STATUTES WHICH LIMIT OR PRECLUDE DEVELOPMENT ON WILDERNESS, WILDLIFE REFUGES, AND OTHER PROTECTED LANDS

APPENDIX E

E-1 Utah Geothermal Sites (Electric)

E-2 Utah Geothermal Sites (Non-Electric)

UTAH GEOTHERMAL SITES (ELECTRIC)

SITE	LAT	LONG	RESERVOIR VOLUME (CUBIC KM)	TEMPERATURE (° C)	STORED HEAT (10x18 CALS)	RECOVERABLE HEAT (MW CENTURIES)	ELECTRIC POTENTIAL (MW FOR 30 YEARS)
ROOSEVELT HS	38 30	112 49	8.00	250	1.128	37	125
COVE FORT-SULPHURDAL	38 36	112 33	22.50	200	2.497	66	221
THERMO HS	38 11	113 12	2.25	185	.229	6	20

NEW MEXICO ENERGY INSTITUTE PSL AA
FEBRUARY 1, 1978

UTAH GEOTHERMAL SITES (NON-ELECTRIC)

SITE	LAT	LONG	RESERVOIR VOLUME (CUBIC KM)	TEMPERATURE (° C)	STORED HEAT (10E18 CALS)	THERMAL POTENTIAL (MW CENTURIES)	THERMAL POTENTIAL (MW FOR 30 YEARS)
JOSEPH HS	38 38	112 11	2.25	140	.169	13	45
RED HILL HS	38 32	112 9	2.25	135	.162	13	43
CRYSTAL HS	40 30	111 58	2.25	135	.162	13	43
ABRAHAM HS	39 37	112 43	2.25	125	.148	12	39
WASATCH HS	40 45	111 55	2.25	120	.142	11	38
MONROE(COOPER) HS	38 31	112 12	2.25	120	.142	11	38
OGDEN HS	41 14	111 58	2.25	110	.128	10	34
STINKING SPR	41 35	112 14	2.25	110	.128	10	34
MEADOW HS	38 58	112 31	2.25	105	.121	10	32
HOOPER HS	41 9	112 12	2.25	105	.121	10	32
UTAH HS	41 24	112 2	2.25	95	.108	9	27
BECKS HS	40 47	111 56	2.25	90	.101	8	27
CRYSTAL H.S.	40 40	112 0	2.25	90	.101	8	27
WILSON HS	39 55	113 40	2.25	61	.062	5	16
MIDWAY HS	40 31	111 28	2.25	45	.040	3	11
SARATOGA HS	40 20	111 53	2.25	44	.039	3	10
UDDY HS	41 51	112 9	2.25	43	.038	3	10
CRATER HS	40 20	111 53	2.25	43	.038	3	10
LAVERKIN HS	37 13	113 16	2.25	42	.036	3	10
VEYO HS	37 19	113 42	2.25	42	.036	3	10
UINAHED HS	41 42	114 7	2.25	42	.036	3	10
CASTILLA HS	40 3	111 29	2.25	40	.034	3	9
HATTON HS	38 57	112 27	2.25	38	.031	2	8
RADIUM(OLSON) HS	38 13	112 55	2.25	33	.024	2	6
LINCOLN POINT WS	40 1	111 50	2.25	32	.023	2	6
SPLIT MOUNTAIN WS	40 27	109 15	2.25	30	.020	2	5
FISH SPRINGS	39 52	113 25	2.25	28	.018	1	5
CANDY WS	39 27	113 58	2.25	27	.016	1	4
MORGANS WS	40 24	112 25	2.25	27	.016	1	4
BLUE WS	41 50	112 24	2.25	27	.016	1	4
WARM SPR	41 48	113 35	2.25	27	.016	1	4
WARM SPR-UTAH LAKE	40 14	111 46	2.25	25	.013	1	4
JOHNSONS WS	38 36	112 15	2.25	25	.013	1	4
COMO HS	41 5	111 40	2.25	25	.013	1	4
GEORGESVILLE	40 38	112 31	2.25	24	.012	1	3
RUSSELS WS	40 22	112 27	2.25	22	.009	1	3
RICHFIELD WS	38 45	112 5	2.25	22	.009	1	3
DIAMOND FORK WS	40 5	111 22	2.25	20	.007	0	2
GOSHEN WS	39 57	111 44	2.25	20	.007	0	2
STERLING SPR	39 12	111 32	2.25	19	.005	0	1
BIG WS	40 52	112 36	2.25	18	.004	0	1

APPENDIX F

F-1 Financial Statement for the Utah Operations/Research Study

FINANCIAL STATEMENT FOR
THE UTAH GEOTHERMAL OPERATIONS/RESEARCH PROJECT

The following is the financial statement for the Utah portion of the Southwest Regional Geothermal Operations/ Research Project. It is current as of June 30, 1978. Because of the 60-day extension (until August 12, 1978), there will be further expenses accounted to the project fund which are not reflected here.

	Allotted Funds	Expended June 30, 1978
Payrolls	$24,000	$15,529.12
Travel	4,000	1,0 8.03
Capital Expense	12,500	70.63
Capital Outlay	1,500	1,173.00
Total	$42,000	$17,840.78